CALIFORNIA MARINE LIFE PROTECTION ACT INITIATIVE

DRAFT MONITORING, EVALUATION AND ADAPTIVE MANAGEMENT FRAMEWORK

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CONTENTS

1. Overview: Marine Life Protection Act Statewide Framework for Adaptive Management and Monitoring & Evaluation

The Marine Life Protection Act (MLPA) requires adaptive management, monitoring and evaluation to ensure that that an effective system of marine protected areas (MPAs) is created and maintained for decades to come. Monitoring and evaluation are critical to determine if goals are being met over time and then inform adaptive management to refine MPA design, management and policy.

This document outlines a suggested statewide Monitoring, Evaluation and Adaptive Management Framework (ME&AMF) for MPAs. It proposes and recommends a structure and process, as well provides guidance for the state and regions on how to implement monitoring, evaluation and adaptive management.

1A. MLPA Requirements for Adaptive Management and Monitoring & Evaluation

The MLPA requires adaptive management to ensure that a system of MPAs meets its stated goals (Section 2853 (c) (3)). The law embeds ecosystem level adaptive management, monitoring, and evaluation into the state policies and management of marine resources and MPAs. This approach will require the state to develop and implement a cutting edge monitoring, evaluation, and adaptive management program. The MLPA defines adaptive management as "a management policy that seeks to improve management of biological resources, particularly in areas of scientific uncertainty, by viewing program actions as tools for learning. Actions shall be designed so that, even if they fail, they will provide useful information for future actions, and monitoring and evaluation shall be emphasized so that the interaction of different elements within marine systems may be better understood" (Section 2852 (a)). Adaptive management requires learning from current experience to improve the process of achieving the goals of the MLPA over time. Success requires:

(a) appropriately scaled, sustained institutional capacity to make legitimate choices,
(b) possession and use of relevant information,
(c) use of (a) and (b) to effect desired changes in policies, programs, and human behaviors intended to achieve the goals of the MLPA.

California's Marine Life Protection Act (1999) builds upon the state's prior efforts to protect and manage marine resources. It combines five important policy innovations that require:

(a) the creation of systems of MPAs as a necessary element in achieving desired marine policy goals (complementary to, but regardless of, the effects of traditional fisheries management policies),

(b) the use of three classifications of MPAs (state marine reserve, state marine park, and state marine conservation area), with each protected area to be created with specific objectives,

(c) the development of networks of MPAs on a biogeographical region scale, designed to accomplish the complex goals of the MLPA by protecting ecosystems, and

(d) the adaptive management of the network or system of MPAs to better achieve the goals of the MLPA over time.

There is little experience to guide the development of a statewide adaptive management, monitoring, and evaluation framework for MPAs, which includes design of the institutional structure and processes to achieve adaptive management. One consequence of being at the forefront of policy development concerning monitoring and evaluation of MPAs, as is the case with the MLPA, is that few direct models exist from which to learn. Of necessity, this framework draws upon available experience from many policy areas, theories, and MPA case studies about improving decision-making and policies over time.

A recent review of ecosystem monitoring of protected areas (Chornesky 2005) provides useful suggestions for developing data, information structures, and information flows to inform management of ecosystems. That report does not address the institutions within which adaptive management must occur. Thoughtful exploration of developing natural and social indicators of the performance of individual MPAs is also available (Pomeroy, Parks and Watson 2004). That volume, however, mentions networks of MPAs only very briefly. It does not consider indicators which may be appropriate for adaptive management of an MPA array or network at the scale the MLPA requires protection nor does it address process and institutions within which adaptive management can occur.

The MLPA Master Plan Framework (MPF) adopted by the Fish and Game Commission on August 18, 2005, provides little direct guidance on the institutions and processes for adaptive management. Like the Pomeroy, Parks, and Watson (2004) volume from which it draws, the MPF discussion focuses on how to develop a monitoring program in order to judge whether MPAs are accomplishing adopted goals and objectives (CDFG, 2005: pages 69-75). However, the discussion and flowchart of the nesting of goals at various scales, from statewide to region to individual areas to individual MPAs (CDFG, 2005: Figure 3, page 35), suggest some of the challenges in sorting out relationships important for adaptive management (for further discussion see Section 2).

This document develops a framework for the adaptive management, monitoring, and evaluation of ecosystems within biogeographical regions. The framework includes discussions of the choices confronted regarding institutions and processes to be developed. It also advances guidance for monitoring and evaluation of both ecosystems and specific MPAs that will, in turn, inform both adaptive management and day-to-day management of MPAs. More specific monitoring and evaluation plans will be required as networks or network components consisting of specific MPAs are designated (see Section 4 for further information).

1B. Purpose of this Framework

An important part of large-scale comprehensive marine ecosystem management is the establishment of programs to monitor, evaluate, and adaptively manage biological, social, and economic status and changes in the areas within, nearby, and distant from the MPAs. The MEAMF is not for fisheries management monitoring, but rather exists to provide guidance for monitoring and to ensure protection and conservation of the unique and diverse marine ecosystems of California. Long-term monitoring data are critical in order to understand the status and trends of resources and identify emerging threats. Monitoring and evaluation will help managers, policymakers, scientists, and stakeholders determine the impacts and effectiveness of the MPA array. Data will be used to evaluate the progress towards achieving the statewide goals, regional goals and objectives, and objectives for individual MPAs established by the MLPA and by the regional stakeholder groups. Finally, these data will be used for adaptive management of the MPAs.

Adaptive management provides many benefits and has many purposes. Over time adaptive management can improve policy, practice and knowledge. Some of the benefits and purposes include:

(a) Improving MPA Design, Management Effectiveness and Implementation: Adaptive management can be applied to many resources and systems at many scales. Monitoring can be designed so that management approaches and actions at specific sites or ecosystems can be compared and information used to continuously improve management. Adaptive management can provide answers to questions surrounding uncertainty associated with outcomes of policies

(b) Increase Understanding of Ecosystem Function and Sustainability: Adaptive management can provide insight into scientific uncertainty for marine ecosystems. Answers to questions may shed light on ecosystem function, on large-scale ecosystem level relationships, and thresholds in ecosystem response to activities in determining which activities are sustainable and which are not (Lee, 1999).

(c) Efficient and Effective Monitoring: When implementing the ME&AMF there is an opportunity to think and select ahead of time adaptive management questions that could be answered in the future. Adaptive management will produce a monitoring program that is more efficient and effective because it well-planned and focuses resources and efforts on indicators and knowledge useful to policymakers, stakeholders, managers, and scientists (Taylor *et. al*., 1997).

Data will be collected to measure the effectiveness of the tools implemented to protect and conserve the marine ecosystems. Thus, this framework will provide the infrastructure for a systematic approach to improve marine conservation learning as well as enhance the creation of best policies and management practices. There are very few, if any, examples of the sort of framework the state is developing, so a great opportunity exists for California to lead this effort. However, implementing the ME&AMF will be expensive. MLPA staff are addressing the funding issue by assessing options and making a recommendation to the MLPA Blue Ribbon

Task Force (BRTF) on the best financing mechanisms that would ensure long-term funding of management and implementation of the ME&AMF.

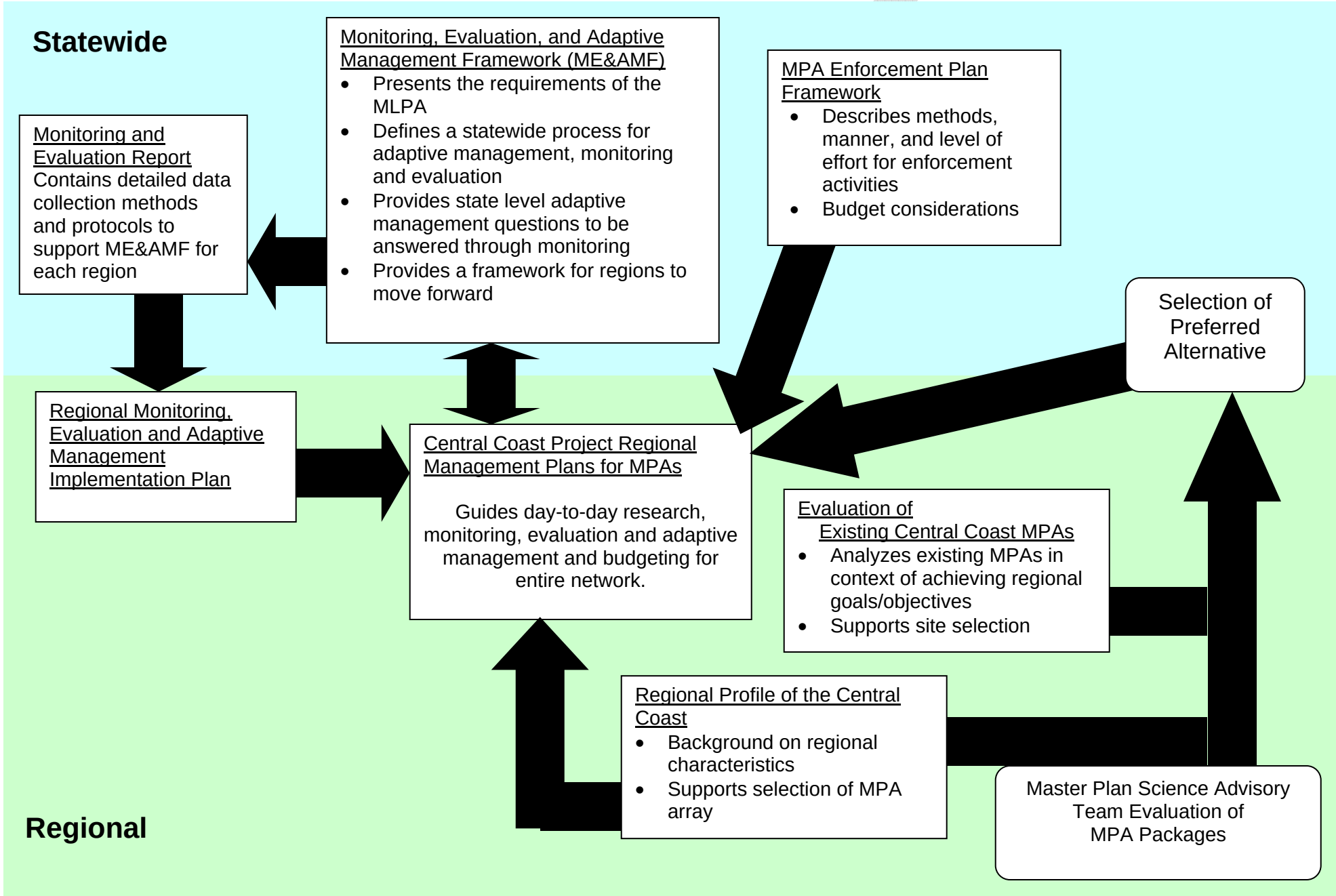
The ME&AMF is based upon five basic principles. The framework should: 1) be useful to decision-makers, managers, scientists and stakeholders for improving MPA design and management; 2) be practical in use and cost; 3) include of both scientific and stakeholder input; 4) be flexible for use at different sites and in varying conditions; and 5) be holistic in its focus on both natural and human perspectives (Master Plan Framework, Section 6; 69).

This *Monitoring, Evaluation, and Adaptive Management Framework* is just one element of the MLPA. This framework will need to mesh with the regional MPA management plans such as the *MLPA Central Coast Project Regional Management Plan for Marine Protected Areas* (Central Coast Project Plan) and implementation of the management plan (see Figure 1). The *Central Coast Project Plan* will provide guidance for day-to-day management, research, education, enforcement, monitoring, and budgeting. It will also supply the reasoning for specific MPAs within the network component that should be monitored and evaluated (Appendices to MPF, 2005). In addition to the regional management plans for MPAs, a *Marine Protected Areas Enforcement Plan Framework*, outlined in the MPF, will describe the essential components of an effective enforcement plan to protect and preserve the marine resources statewide (Appendices to MPF, 2005).

Other reports developed in this process will contribute significantly to the ME&AMF. The *Regional Profile of the Central Coast Study Region* (Regional Profile) (MLPA, 2005) provides background information and data on the biological, oceanographic, socioeconomic, and governance characteristics of the central coast study region. This profile, completed in September 2005, was intended to assist the MLPA Central Coast Regional Staekholder Group (CCRSG) in developing regional objectives, evaluating existing MPAs within the central coast study region, and developing alternative proposals for MPAs. After the California Fish and Game Commission has adopted a package of MPAs for the central coast region, information from the *Regional Profile* will be used to assist with the research design of the monitoring for the ME&AMF. The best readily available data are being compiled for use in the Central Coast Project planning process. All of the data that are in a spatial geographic information system (GIS) format are being housed in a new California Marine Geodatabase at the University of California, Santa Barbara (see the Internet Mapping Service site at http://maps.msi.ucsb.edu/mlpa). In addition there is a data layer of monitoring sites that includes the location and type of data collected at the sites.

The *MLPA Initiative Evaluation of Existing Central Coast MPAs* (MLPA, 2005b) and *SAT Evaluation of MPA Packages* also provide an analysis of existing studies within each existing MPA and discuss whether the areas are meeting their original goals and whether they can achieve regional goals and MLPA requirements. These documents are an excellent source of information to retrieve and access relevant, available data for baseline purposes or to help in determining site selection.

Figure 1: Development of Documents Related to Monitoring, Evaluation and Adaptive Management in the MLPA Process



A monitoring and evaluation report, a report to describe the detailed methods for monitoring and evaluation statewide, will be developed for the state and then each region will develop a plan to implement the ME&AMF with regional monitoring, evaluation, and adaptive management implementation plans. The report will describe the research design as well as a compilation of the methods used to collect the data to create a uniformity of data methods, collection, and management. This will be developed at a later date. For further discussion on the regional implementation plans, see Section 4 and an illustrative table of contents in Section 4D.

1C. Adaptive Management in the Marine Life Protection Act

The MLPA requires adaptive management to ensure that the system of protected areas meets its stated goals (Section 2853 (c) (3)). The Act intends the creation and management of multiple MPAs as a network to protect marine life, habitats, and ecosystems (Section 2853). The Act clearly distinguishes between individual MPAs, with each expected to meet its specified objectives, and the network of MPAs as a whole, which is expected to meet the goals of the Act (Section 2857 (c) (5)). Individual MPA objectives will feed into regional goals and objectives and those, in turn, will feed into goals of the Act at the state level (See Appendix 2 and 3 on MLPA Goals and Central Coast Regional Goals and Objectives). The MLPA also requires that decision-making be based on the best readily available science and informed by stakeholder participation.

The definition of adaptive management used in the MLPA is consistent with contemporary understanding of this approach to improving policy performance over time, with one exception. Adaptive management seeks to address uncertainty about both (a) the natural and human systems within which policy is being implemented, and (b) the effects of the policy instruments being deployed. The MLPA does not mention uncertainty regarding human systems or policy instruments, both important to address in adaptive management. The intent of adaptive management is to learn more about both natural and human systems and policy instruments by “doing” policy implementation in ways that allow learning and adaptation over time.

Application of adaptive management for the MLPA can draw upon other experiences from the past decade in riparian and coastal marine ecosystems. Generally the term refers to a structure and process of “learning by doing” that involves more than simply better ecological monitoring and response to management impacts (Walters, 1997). From the perspective of science, discussion of adaptive management often focuses on formal understanding of the relevant natural and human systems and designing policy instruments as research questions designed to produce answers. Less attention is paid to issues of political context or administrative capacity (Committee on Grand Canyon Monitoring and Research, National Research Council 1999). When the perspective shifts to policy making and implementation, the importance of good science regarding understanding affected systems remains, but more attention is paid to achieving political legitimacy and support and understanding the capacity and culture of agencies implementing the policies (Panel on Adaptive Management for Resource Stewardship, National Research Council 2004).

Lee (1999) places adaptive management in a long lineage of efforts to understand and improve policy formation and implementation. According to Lee, adaptive management has particular relevance to policy areas characterized by disagreements about both policy outcomes and the causation of problems and of policy instruments. These conditions occur frequently regarding natural resources and certainly describe the state of marine resources. Importantly, assessments of adaptive management in practice reveal that its use must be "adapted" to the specific legal, institutional, and cultural contexts in which it is applied (Panel on Adaptive Management for Resource Stewardship, Natural Research Council 2004; Gray 2000).

This framework for adaptive management is explicitly grounded in the legal, institutional, and cultural context of marine policies in California. It also addresses how to satisfy the needs for improving scientific understanding of the relevant natural and human systems and policy instruments over time.

Scale for Adaptive Management in the MLPA

Sorting out possible relationships in this complex interplay of natural systems, such as biogeographic regions or ecosystems, and the units of administrative action created by the MLPA, such as MPAs or networks of MPAs, is difficult. As a first challenge, the manner in which people define terms, from a physical area to a time frame to a concept, is often in flux. For example, the boundaries of the natural systems are often defined differently, seen in the discussions among members of the MLPA Master Plan Science Advisory Team about whether two, three, or more biogeographic regions exist in California. The boundaries of the administrative units are defined by policy choices, but those are often hotly contested and change over time.

More fundamental challenges arise in determining the appropriate scale for consideration of adaptive management (e.g. should it be ecosystem or biogeographic region?), in design of appropriate institutional structure and administrative processes. The implementing entities need to have capacity and incentive to make and implement adaptive management decisions, and in the design of data collection, management, and analytic strategies to support adaptive management decisions at those scales. Moreover, while adaptive management is appropriately episodic, occurring every several years over long periods of time, operational decisions regarding adjustments in enforcement, education, and data collection need to be made for individual MPAs on a much more frequent basis, perhaps even monthly (for further discussion see section 3A)

Decisions in Adaptive Management

The MLPA defines adaptive management as "a management policy that seeks to improve management of biological resources, particularly in areas of scientific uncertainty, by viewing program actions as tools for learning" (Section 2852 (a)). Adaptive management, or "learning by doing," relies on many factors: the collection of monitoring data, research to determine cause-and-effect relationships, evaluation of management measures and ecological indicators,

communication of new information, transparent decision-making, and stakeholder participation and input.

Based on existing knowledge, several divergent approaches to adaptive management, which creates a feedback loop between the management action and the effect of that action on an ecosystem, could meet the ecological goals stated in the MLPA. Each approach involves diverse players (from scientists to policymakers and stakeholders), different understandings of cause-and-effect relationships, and various desired outcomes and social and economic implications. Not surprisingly, consensus is difficult to reach. It is unrealistic to expect that stakeholders, scientists, and policymakers will agree upon a common vision. Given the existence of disagreements about preferred policy outcomes and causation of problems, political controversies, technical difficulties, uncertainty about relevant natural and human systems, and multiple stakeholder interests, adaptive management is difficult to implement well. Two things are clear: 1) the process needs to be transparent; and 2) it needs to involve the stakeholders and anticipate programs of public education, outreach, and public involvement.

One of the major challenges that effective implementation of adaptive management faces is understanding the types of decisions that need to be made about causation and outcomes (or ends and means). Such decisions relate to both scientific research and political questions. Lee (1999; 1993, chap. 4, modifying Thompson and Tuden, 1959) presents a theoretical matrix commonly used by analysts to help make policy decisions in situations characterized by conflict. According to Lee, adaptive management has particular relevance to policy areas where stakeholders disagree about policy outcomes and the causation of problems and of policy instruments. One of the big variables in these situations is the role of scientific research. If oftentimes scientists poorly understand and/or disagree about causation, how is it possible to find a structural solution to a problem? How can disputes over ecosystem conservation be resolved? Scientists are still trying to understand natural systems and confidently discern cause-and-effect relationships. For example, a range of views exists for meta-data analyses from the current marine reserve literature, and scientists cannot conclude with confidence the degree of the reserve effect, rates of recovery of extracted species within no-take reserves. One view argues that recovery processes are rapid (1-3 years) and abundance is consistent across reserves of all ages and another group argues that duration of protection inside and outside no-take reserves to ensure full recovery of species may take three to four decades (Russ *et. al*, 2005; Halpern & Warner, 2002; and McClanahan, 2000). Part of this debate may be due to definitions of recovery.

Lee offers two paths that can be applied to adaptive management. The first, *planning*, is commonly applied to environmental problems and is meant to defer conflict. However, in this process, scientific ideas such as adaptive management or a biogeographical template may be perceived as “scientific trouble-makers.” This perception, in turn, may engender more resistance to collaborative planning and handicap the scientific research process to the point where scientific experiments may become unreliable and shape, in turn, the perception of findings. The second path, *settling*, involves disputants with different preferences about the outcomes. However, although in an environmental settlement negotiation agreement on the

questions about causality that all parties want answered may eventually be reached, settling may not achieve common ground. Thus, settling is not appropriate for adaptive management, which needs legitimization. In principle, scientific research is legitimate and can slowly lead to reliable determination of causes, especially if the most important uncertainties are tested rigorously and early and peer reviewed. Scientific research can thus be used to pursue a common agenda. However, further and/or ongoing research may be necessary to ensure valid results.

While differences in decision-making and desired outcomes are inevitable, an orderly approach to resolving these differences is essential to addressing unavoidable questions and conflicts about "best" approaches, definite causations, and preferable outcomes. Given the many variables involved in making decisions about adaptive management, a collaborative structure should be in place *before* an adaptive management exploration of the landscape proceeds. Since adaptive management will lead to a political resolution of policy choices, it is important to use scientific research to answer researchable questions that are defined by all stakeholders involved to serve the choices being made.

These theoretical issues point to the importance of considering different concrete approaches to adaptive management. Adaptive management can be implemented in various ways. At one end of the spectrum, it can be a rigorous approach for learning through analyzing design and implementing management actions as experiments, specifically to learn how the system responds to management and how best to achieve desired results (Murray and Marmorek, 2004, Walters, 1986). It can include explicit articulation of hypotheses, designing experiments to test these hypotheses, and then monitoring outcomes to refine hypotheses and build knowledge (Taylor et al, 1997). Walters (1997) defines adaptive management as "a structured process of continuous improving management performance through "learning by doing and measuring." However, adaptive management should involve more than just monitoring and responding to unexpected impacts. It should also include the application of dynamic models that attempt to make predictions about the impacts of alternative policies (Day *et. al*, 2002). On the other end of the spectrum, adaptive management can occur at the end of the project cycle of M&E and be a compilation of lessons learned.

Ideally, effective adaptive management should occur during three different stages:

- Scientific and stakeholder input, planning, and prioritization input set in place at the start of a project.
- Scientific and stakeholder input, planning and prioritization, monitoring, ongoing, evolving, and modified throughout program life (or stage).
- Scientific and stakeholder input, planning and prioritization, and monitoring evaluated at end of project ("lessons learned"), with future management strategies and policies adjusted accordingly.

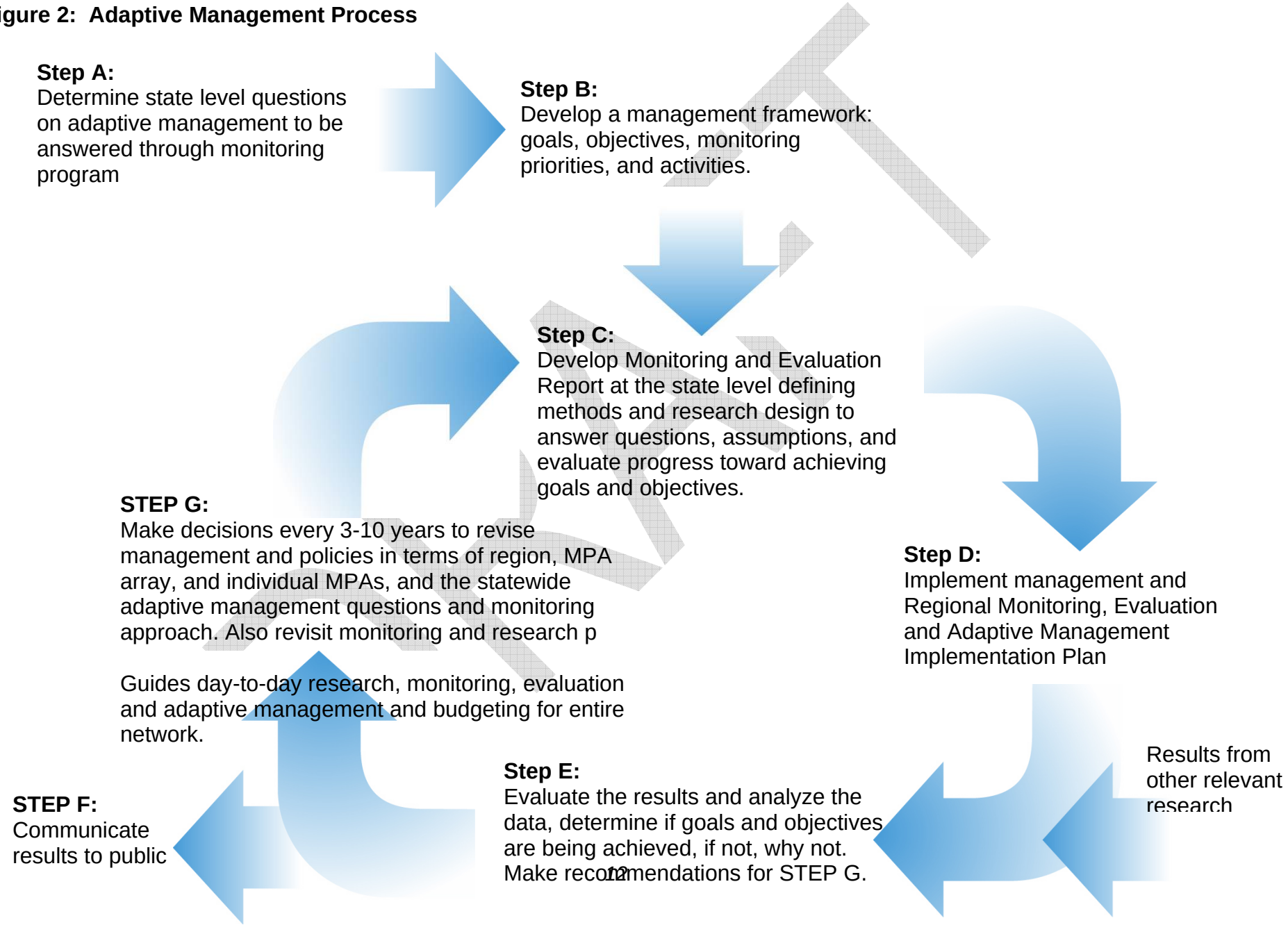
Setting in place a management policy, implementing it, and then mobilizing a monitoring plan that evaluates management and policies requires that an adaptive management framework be

in place. But designing such an adaptive management framework is complex. The June 2005 report *Protecting America's Marine Environment: A Report of the MPAs Federal Advisory Committee on Establishing and Managing a National System of MPAs* outlines the expert advice and recommendations of 30 people with diverse interests and experience representing academia, government agencies, NGOs, business interests, and other interested organizations (represented by participants such as Dr. Agardy and Dr. Fujita). According to the report, adaptive management should:

- be both "top-down" (guided by federal, state, and tribal authorities) and "bottom-up" (meaning it engages all interested parties);
- be a standard part of the management and planning process;
- rely upon monitoring, evaluation of objectives and indicators, and research that together determine cause-and effect relationships between xx and yy;
- be sensitive to experiments and management protocols where potential exists for reverse impacts on stakeholder livelihood;
- be sensitive to user conflicts;
- include research hypotheses to inform particular monitoring programs and data from the monitoring activities that then facilitate management decisions;
- include both social and natural sciences for formal research, with a scope of both basic and applied research;
- include participatory research using customary and local knowledge. This is important because it facilitates communication, education, and trust that, in turn, lead to the possibility of good stewardship;
- integrate monitoring and research program that will enhance stewardship. The dissemination of information can create transparency and enhance trust;
- include evaluation of MPAs, which is a critical element of adaptive management and should be planned on a schedule, be transparent, and have clear objectives and criteria;
- include effective communication and public participation components; and
- employ external review (FAC, 2005).

This guidance, along with some of the definitions and examples above, provides the basis for the framework on how to integrate adaptive management for MLPA and each region. Designing this procedure **at the start of the program** provides an opportunity to lay out a clear, efficient, and effective process (see Figure 2)

Figure 2: Adaptive Management Process



Clear rules and procedures for comment, dialogue, and participation are important not only at the start of adaptive management, but throughout the entire process and at its end. Thus, changes in decisions to policy and management may occur throughout the process as well as at the end of a specific cycle or program. Translating results into changes in policy and management practices is a complex process for a number of reasons:

- First, given the high variability in data, we need to determine how much data is needed to have a significant result. Furthermore, scientists still have difficulty discerning definitive cause-and-effect relationships.
- Second, over time we need to identify relevant change or threshold ranges for indicators in order to translate the result into a change in policy or management. Evaluations of MPAs, are a critical element of adaptive management and should be planned on a schedule, and have clear objectives and criteria in order to make the process transparent (FAC, 2005). The objectives and criteria for measuring success also need to be spelled out clearly. Policymakers and stakeholders, with the assistance of scientists, need to establish goals, objectives, and priorities. Policymakers and stakeholders need to think about what they value most and what success means for them in terms of achieving the goals in the context of the goals and requirements of the MLPA the next few decades. After the priorities are determined and defined by the MLPA Adaptive Management Council (AMC) (see section 2C for explanation and description), the AMC will need to determine, based upon the stated goals and priorities, the best indicators to measure success and whether or not it is possible to set a benchmark or threshold range to measure success. The scientists on the AMC will need to outline the limits (acceptable deviations from specific targets) (Syms and Carr, 2001).
- The third aspect to consider is the process for making the decision. This question returns to how to design the adaptive management process; key recommendations from FAC 2005 are explained above. A multi-stakeholder committee structures prioritize goals and objectives, in order to review results and make recommendations to the California Department of Fish and Game (CDFG) and Fish and Game Commission. This committee is essential to gaining the trust and support of all stakeholders and the long-term management goals of the MPA array.

The Great Barrier Reef Marine Park Authority (GBRMPA) offers a successful case study of how adaptive management can work. In the GBRMPA, which uses an ecosystem approach to management, Day (2002) discusses the critical roles that adaptive management and monitoring have played over the past 25 years. The author uses the definition of adaptive management by Parma *et al*.: “managing according to a plan by which decisions are made and modified as a function of what is known and learned about the system, including information about the effect of previous management actions.” They suggest that, “we cannot hope to understand the complex system we are trying to manage unless we experiment with it.” These are the key components:

- A management policy;

- A management system that implements policy; and,
- A monitoring plan to determine system responses and provide a basis for adjusting management.

Day (2002) summarizes an example in the GBRMPA, where a conservation group opposed an experiment on the effects of line fishing because it opened reefs to fishing that had never before been fished. Although conservationists and fishers were at odds, the example illustrates that adaptive management embraces the philosophy that future actions will change as new information is made available and require flexibility from decision-makers. Hockings et al. (2000) discuss the role of adaptive management in the evaluation of MPA effectiveness and state that adaptive management is critical to provide evidence-based feedback on what's working and what's not, which allows for review of policies and practices by decision-makers. It is also an opportunity to learn more about the MPA, including the ecological nature of the MPA, its dynamics, and interaction between the systems with management approaches/decisions. The GBRMPA provides just one approach to adaptive management; such management in California will draw from existing examples as well as tailor its management to the state's specific conditions.

1D. Cross-Cutting Themes

There are a number of cross-cutting themes to consider in the development and implementation of the ME&AMF for large-scale marine environments. Throughout this document these four themes will emerge because of their importance and/or complexity when putting such a framework together:

- Spatial and temporal issues
- Uncertainty of data
- Quality control of data
- Stakeholder participation

Spatial and Temporal Issues

In order to understand the trends and patterns of indicators being measured, scientists must have a thorough comprehension of the spatial and temporal factors that could influence data collection and analysis. For example, behavioral patterns, migration, and movement of species, populations, and individuals can change annually, seasonally, or over decades. Such variability requires data collection of different indicators at different locations and time intervals. Furthermore, natural spatial variability can confound control effects if the parameters of interest differ prior to the effect that is being measured (Osenberg and Schmitt, 1996). Conceptual models of the ecosystem that incorporate relevant temporal trends and patterns of indicators are ideal to ensure effective monitoring (for further discussion, see section 3).

Uncertainty of Data

Translating results into changes in policy and management practices is a complex process for a number of reasons. First, given the high variability in data, we need to determine how much data is needed to show significant results. Second, scientists are still trying to understand marine systems and confidently discern cause-and-effect relationships. Third, MPAs need long time horizons for detecting changes in marine systems (NFCC, 2004). The issues surrounding data uncertainty will influence the evaluation and adaptive management processes by requiring results to show relative change over the course of years, if not decades (for further discussion, see section 4B).

Quality Control of Data

Data quality control and assurance is critical in gaining precision and credibility now and for the future; it is critical to obtain data and results that will inform public processes (Chornesky, 2005). Enforcing universal methods for collection and storage of data as well as establishing an integrated statewide data management structure will prevent problems often associated with data and analysis of large data sets for large-scale areas. Data sets will have different requirements. Furthermore, to ensure this credibility, it is important to establish a peer review process of disinterested parties to review these data (for further discussion, see section 3B).

Policymakers and Stakeholder Participation

The literature and experience in MPA and fisheries monitoring emphasize the strategic importance of involving policymakers and stakeholders early on in shaping monitoring and adaptive management priorities (See Appendix I: Case Studies of Existing MPAs Monitoring & Evaluation Plans and Pomeroy 2004; NRC 1990, 2001; FAC, 2005). In fact, the authors of the 2001 National Academy of Science report argued that millions of dollars in monitoring proved of little use partly because the questions were framed by scientists operating apart from the users of the information (NRC, 2001).

The rationale for such policymaker and stakeholder involvement lies in the fact that questions about what to monitor, why, and what it all means are not merely technical issues. Rather, answering these questions requires implicit judgments about values (e.g. of marine resources, socioeconomic factors, etc.) as well as technical issues that neither policymakers, stakeholders, nor scientists can resolve independently. Therefore, in order to have the best chance of soliciting input from both stakeholders and policymakers about the ME&AMF priorities and specifics of implementation, we recommend that policymakers and stakeholders engage in conversations about these implicit values (to make them explicit) and the relationship of values to monitoring, evaluation and adaptive management in the context of the MLPA goals and requirements. This conversation should take place at an early point in the development process for the monitoring plan after selection of the preferred alternative. Although there will still be a large amount of work that scientists and specialists will have to address in terms of identifying questions, stating assumptions, and constructing models, the

more technical aspects of the work may not be appropriate for extensive participation by policymakers and stakeholders.

The Federal Advisory Committee on Establishing and Managing a National System of MPAs states that "effectiveness of MPAs in accomplishing their goals and objectives is heavily dependent upon the development of the shared concept of individual and collective stewardship" (FAC, 2005). Effective stewardship will need effective communication among all interested and affected policymakers, stakeholders as well as the general public. Whenever possible, local knowledge and co-management strategies need to be incorporated into the planning process (FAC, 2005).

Policymaker and stakeholder involvement is critical for long-term success of the MPA array. Effective communication and clear guidelines of participation are important aspects to think about now and for the future. For the ME&AMF, policymaker and stakeholder involvement in translation of objectives into questions is important, as is the continual dialogue of reporting results and decisions in a format that caters to all policymakers, stakeholders and the general public. The adaptive management process needs to include a role for stakeholder participation; a committee structure is the most common practice. The more transparent and forthright the process is, the more effective it will be in gaining stakeholder trust and support and increasing the likelihood that stakeholders will become stewards.

2. Adaptive Management at the Ecosystem Scale

Ecosystem scale adaptive management is designed to improve and change policy and management practices based upon monitoring and evaluation results. The goals of the MLPA are to restore and sustain the health, productivity, resilience, and biological diversity of the unique Californian coastal marine systems as well as promote the quality of life for humans who depend on and enjoy them. The ME&AMF is designed for the ecosystem scale. It is grounded in science and defines goals on the basis of ecological, rather than political, boundaries and addresses ecological, social, and economic goals. The development and implementation of ecosystem scale management are critical in ensuring sustainability in California's coastal marine systems, a key goal of the MLPA.

2A. Scale of Adaptive Management

In 1999, the Governor of California signed the Marine Life Protection Act (MLPA), which mandates that the existing array be improved upon and functions as a network. The MLPA Initiative has taken a regional stepwise approach in developing components of a statewide network of MPAs. The Central Coast Study Region is the first region to begin implementing the MLPA, but other regions north and south of the central coast sites, including the Channel Islands, ultimately will be part of this statewide MPA array. The entire MPA array will be adaptively managed at the ecosystem scale.

The statewide goals for the MLPA are stated in Section 2859, a Marine Life Protection Program, and shall have the following goals:

1) To protect the natural diversity and abundance of marine life, and the structure, function, and integrity of marine ecosystems.
2) To help sustain, conserve, and protect marine life populations, including those of economic value, and rebuild those that are depleted.
3) To improve recreational, educational, and study opportunities provided by marine ecosystems that are subject to minimal human disturbance, and to manage these uses in a manner consistent with protecting biodiversity.
4) To protect marine natural heritage, including protection of representative and unique marine life habitats in California waters for their intrinsic value.
5) To ensure that California's MPAs have clearly defined objectives, effective management measures, and adequate enforcement, and are based on sound scientific guidelines.
6) To ensure that the state's MPAs are designed and managed, to the extent possible, as a network.

Many of the statewide goals support regional goals and objectives (See Appendix 2 and 3 on MLPA Goals and Central Coast Regional Goals and Objectives and Design Considerations). Central coast goals range from a broad regional perspective to a focused perspective applied to individual MPAs in the array. Because individual MPA objectives can logically only be derived from the broader regional goals and objectives, these broad goals and objectives must be established first. A critical first step in the adaptive management process is to establish the desired outcomes for the process. In the case of the central coast MLPA Initiative array, desired goals and objectives were developed at the regional level. In addition, the stakeholders developed a series of “design and implementation considerations” to further guide the creation of alternative packages of proposed MPAs. The members of the CCRSG agree that regional goals, objectives, and design and implementation considerations are all very important in the development of effective network components of MPAs that have stakeholder support. This is an opportunity for stakeholders and policymakers to develop clear priorities and definitions of success. Regional \goals are statements of what the regional MPAs are ultimately trying to achieve (Pomeroy et al. 2004). The regional goals are largely taken directly from the MLPA. Regional objectives are more specific measurable statements of what must be accomplished to attain a related goal (Pomeroy et al. 2004). For example, regional objectives (below) under regional Goal 3 support the statewide Goal 3.

Central coast MLPA Initiative objectives for Goal 3 are the following:

1) Ensure some MPAs are close to population centers and research and education institutions, include areas of traditional non-consumptive recreational use, and are accessible for recreational, educational, and study opportunities.
2) To enhance the likelihood of scientifically valid studies, replicate appropriate MPA designations, habitats, or control areas (including areas open to fishing) to the extent possible.

3) Develop collaborative scientific monitoring and research projects, evaluating MPAs that link with fisheries management information needs, classroom science curricula, volunteer dive programs, and fishermen of all ages, and identify participants.
4) 4) Protect or enhance recreational experience by ensuring natural size and age structure of marine populations.

Within a particular region, there may be MPA site-specific objectives that help support both the regional and statewide goals. The regional goals and objectives in turn guide the MPA siting as well as objectives of the individual MPAs. For example, regional Goal 3 may be supported by promoting university research in a particular MPA or building infrastructure to promote visits by school children to a different individual MPA. Figure 3 illustrates the relationship between the statewide goals, regional goals and objectives, and site-specific objectives for the MLPA network component. The relationship is twofold. It cascades from the state to the regional and then to the site level, where the state goals guide the regional goals and objectives, and the regional goals and objectives guide the individual MPA objectives. It is also cascading from the site to the regional to the state, where the sites achieve objectives, and by scaling up and aggregating at the site level, goals and objectives will be achieved at the regional level, and thus when regions are scaled up aggregated goals will be achieved at the state level.

The cascading relationships are just one way to look at adaptive management, monitoring and evaluation of the goals of the MLPA. In addition, we will need to look at a higher state and ecosystem level. Section 2B explains this further.

2B. Adaptive Management Questions for the MLPA

Adaptive management for the MLPA requires the development of statewide questions to answer over time. Table 1 provides illustrative questions and examples of indicators created by MLPA Initiative staff and reviewed by the SAT. These guiding questions need to be vetted and approved by stakeholders and policymakers. Furthermore once the questions are agreed upon, policymakers and stakeholders need to determine the priorities for monitoring by identifying how they will define success and what indicators are of most value to them in the context of the goals and requirements of the MLPA.

Statewide adaptive management questions can provide guidance for statewide, regional, and site-level monitoring, evaluation and adaptive management creating a more efficient and effective monitoring and evaluation plan that will focus human and financial resources on indicators most relevant to policymaker, managers and stakeholders (Taylor, *et.al*., 1997).

Figure 3: Illustration of Process to Translate a Statewide Goal to Regional Goal and Objective to Site Specific Objective

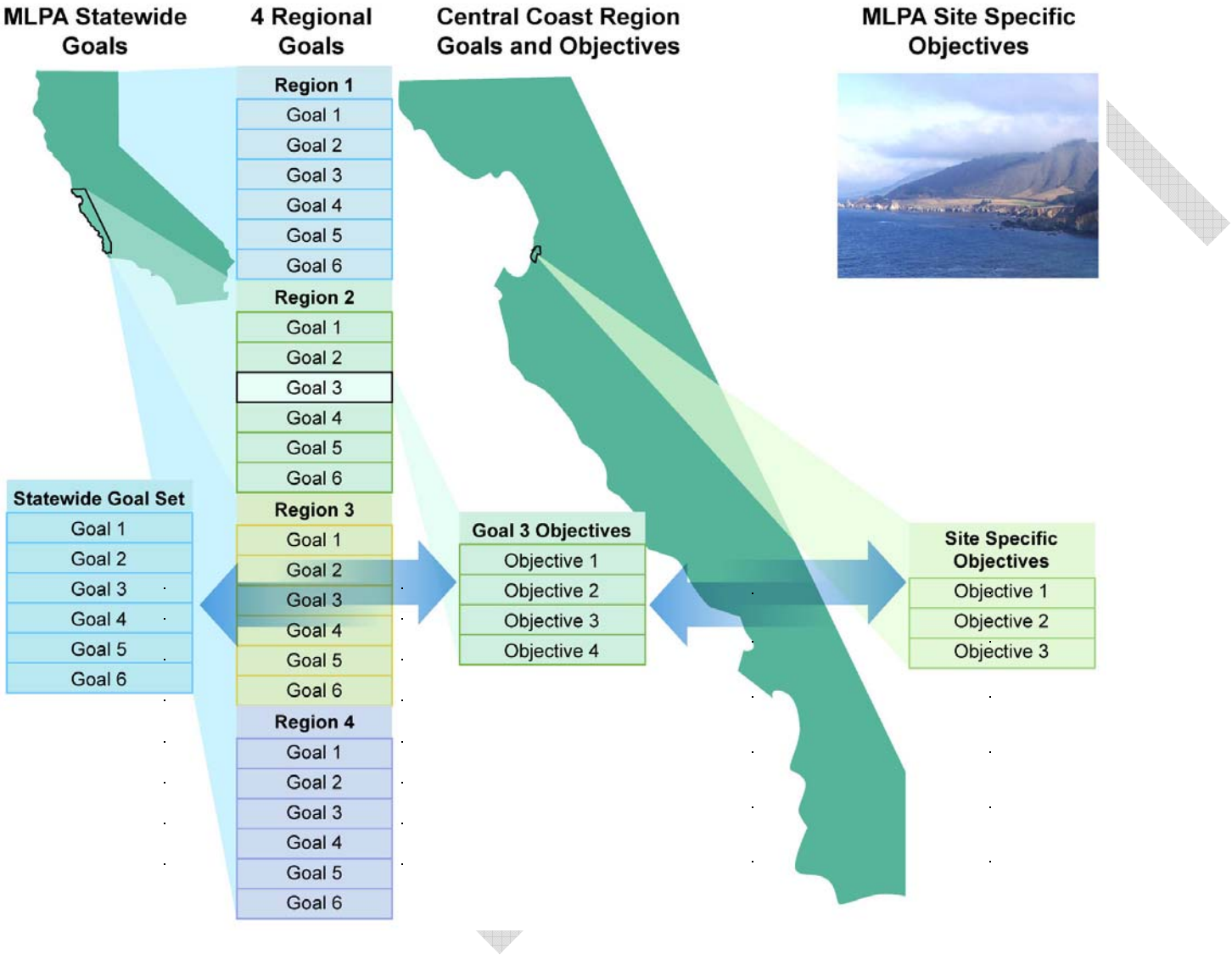


Table 1: Statewide Adaptive Management Questions for the MLPA

Topic Area	State Level Question	Examples of Possible Indicators[1]	Issues to Consider
1. Biological/Ecological	a. Is there a minimum habitat size necessary to maintain or protect habitat, communities, or populations?	Differential change in focal species size structure, age structure, abundance and/or biomass inside marine reserves vs. marine parks or marine conservation areas vs. outside of different sizes	There will be difficult decisions to make in terms of how to aggregate the data in a meaningful way. And, while aggregation is necessary to make sense of what is going on statewide, such aggregation may diminish the usefulness of the information for the purpose of adaptive management.
	b. Is the array of MPAs protecting all represented California marine ecosystem structure, (e.g. diversity) and the function (e.g. size/age)?	Differential change in selected species richness/diversity inside vs. outside MPAs, abundance and/or biomass inside MPAs vs. outside (maybe focus on key species for these indicators). Aggregate these indicators from individual MPA or regional level to address the objectives of the MLPA goal. Then, the questions could be answered at the State level looking at various categories of marine life (e.g.	Same as above

[1] There are many ways to answers these questions. We have provided solely examples here. There are many questions. Policymakers and stakeholders need to prioritize how to answer these questions.

		intertidal, mammals, commercial fish, etc.). There could then be an overall assessment or report card for this question (SF BAY Health Report Card is a good example). For example, grades could be given for different types of habitats or categories of marine life. This is a great mechanism for public outreach.	
	c. Is the array of statewide MPAs functioning as a network?	Select representative species to determine larval distribution and duration throughout region, adult movements. Gather direct evidence of active dispersal by juvenile and adult fish using tagging studies. Conduct population genetic studies of connectedness of populations along the coast.	Need to ensure that the connectivity metrics or modeling exercises are used in such a way as to provide information that would allow for appropriate adaptive management of the policy and managements tools available.
2. Human Dimension	a. Enforcement: Are human behaviors changing in such a way as to support achievement of the MLPA goals?	Analyze rates and patterns of non-compliance infractions/violations (of regulations governing allowable behaviors inside MPAs, e.g. prohibited fishing, poaching, invasive or destructive recreation) and fishing displacement ~~resulting from MPA establishment. Track~~ changes through time in these indicators. The data to answer this question will come from enforcement records in part. There will also could be some random survey/monitoring performed to ensure	This is a straightforward issue to be translated into a meaningful adaptive ~~management~~ response. If good enforcement records are kept along with some basic random

	level of enforcement effort (i.e. there will be no violations observed if no enforcement action is taken).	behaviors, it should be relatively easy to assess whether or not changes are needed in terms of regulations or operating procedures.
b. Education: Is the public becoming more aware of MPAs and their importance?	This can be accomplished through public and user-group surveys. The regional stakeholder groups and AMC(s) can provide valuable information on the user groups to be surveyed. The survey questions and user group categories need to be established up front because there will be an initial survey and the attitudes will be tracked through time. The user group list will include frequent and infrequent visitors, consumptive users, citizens living in vicinity of MPAs, and perhaps even randomly selected individuals who may or may not be users.	Value of survey depends on quality of question design and good baseline data.
c. Impacts: Are negative (positive) economic impacts to users being minimized (maximized) to the extent possible?	Indicators include collecting information on affected users by measuring demographic changes, passive users, use/attendance/visitation, effort, real value of expenditures associated with these identified uses, number of firms associated with identified uses, revenue and non-market value of usage every 5 years.	This will be difficult data to assess and collect; it very much depends on having a good initial survey and well-defined concept of affected users and the measured activities. The survey

			need to be repeated through time to assess. It would be most useful for adaptive management if the changes can be correlated with some aspect of MPA array structure, administration, or operation that could be adjusted.
	e. Recreational Use: Is non-consumptive and/or consumptive recreation being enhanced?	Quantitative indicators include: increased avidity by individuals (trips/person/year); estimated willingness to pay (or other non-market measures; expenditures per person-day; and, CA recreational fishing survey	Need strong baseline survey and attendance records and methodology to repeat to be able to assess changes through time.
3. Administrative	a. Is the administration of the MPA array (statewide) being conducted in a cost-effective fashion and are there adequate financial and human resources to implement?	Measure dollars per rockfish, dollars per user outcome, or cost per effort of enforcement etc... Monitor statewide staffing levels, patterns of equipment use, enforcement resources, research and monitoring present and future.	What constitutes duplication of effort or expense will have to be defined at some point or discovered through the audit approach.

b. Is there adequate stakeholder and public participation in the administration and decision-making processes? How can it be improved?	Indicators are the perceptions/attitudes of public and agency staff expressed through interviews. These interviews can be conducted periodically by an unbiased third party. Other indicators include number of opportunities for stakeholder input, role of stakeholders in adaptive management process, number of reports and data sets available to public.	This is fairly easy to do and quite important to have continued buy-in from stakeholders. For a modest amount of time and effort, the stakeholder process will be continually improved. If stakeholders know that they are being listened to and that staff want to make this process work even better (by measuring this feature), it will go a long way.
c. Are monitoring data being used to evaluate goals and objectives in a reasonable period of time and to make informed adaptive management decisions?	Indicators include number of data reviews over some time interval, degree of participation by stakeholders, staff, scientists, whether management decisions are influenced by monitoring data, whether or not management questions are being successfully addressed through monitoring/research.	There are subjective terms in this question (reasonable, informed decisions). Answering the question will require honest and unbiased assessment of the adaptive

			participants or through external review of the process by non-participating entity.
	d. Are stakeholders involved in the adaptive decision-making?	Subset of the participation question (b) assessed through interviews. Distinguish the stakeholder role for adaptive management vs. everyday administration. Number of opportunities for input on adaptive management, number of reports or datasets available to public on topic of adaptive management.	
	e. Are individual MPAs and regional MPA components effective in building a statewide "network"?	Information could be collected tracking the number and quality of the following: - joint meetings or seminars attended by staff or stakeholders statewide; knowledge of regional staff about other regions, number of conference calls, production of a newsletter or bulletin; circulation of progress reports or problems encountered; email list-servs, and web-based communication. The various MPAs are bound to have similar challenges, and so all will benefit from mandatory, regular communication with their peers.	This sense of "network" has to do with management and overall effect rather than the more focused scientific definition involving connectivity above.

2C. Adaptive Management Process

Institutions and Work Flows for Adaptive Management

The MLPA requires decision-making regarding creation of MPAs to be based on science (Section 2853 (b)(5), Section 2855 (a)), and informed by scientists participating in an advisory team (Section 2855 (2), Section 2855 (3)), stakeholder involvement (Section 2853 (c)(5), Section 2855 (c), Section 2857 (a)), and public participation (Section 2853 (c)(4), Section 2854)). Any creation or modification of individual MPAs requires action of the California Fish and Game Commission (Sections 2859, 2860 and 2861). The MLPA clearly requires decision-making informed by science, details a particular form of participation for a team of scientists, and calls for stakeholder involvement and public participation.

Formal policy making regarding MPA boundaries and regulations is within the authority of the California Fish and Game Commission, a responsibility that will continue. Indeed, the MLPA requires that after adoption of the master plan for all MPAs, the commission shall "at least every three years, receive, consider, and promptly act upon petitions from the department or any other interested party, to add, delete, or modify MPAs, favoring those petitions that are compatible with the goals and guidelines of this chapter" (Section 2861 (a)).

For these reasons, the institutional structures of adaptive management must include five elements:

1) California Fish and Game Commission, as formal policymaker
2) A body of scientific advisors
3) A process for stakeholder involvement
4) Opportunities for public participation
5) California Resource Agency and California Department of Fish and Game

The membership, powers, and operating procedures of the commission can be changed only by statute, but more flexibility exists in how the other three elements are structured and operate. Importantly, these three elements may be complemented by other institutions, exemplified by the BRTF created by the memorandum of understanding (MOU) foundation of the MLPA Initiative. Similarly, while the commission operates at the scale of the State of California, the institutions to support adaptive management can be designed at other scales.

Thus the main choices in designing institutions and work flows for adaptive management of the MLPA in California focus on these areas:

- Geographical scale
- Structures for scientific advice, stakeholder involvement, and public participation
- Possible additional institutions (such as the MLPA Blue Ribbon Task Force)
- Work flow (which defines the relationships among actors)

Geographical Scale

Adaptive management under the MLPA should occur at the scale of ecosystem or biogeographic region, such as the four regional management areas used in the California Nearshore Fishery Management Plan (North Coast Region, North-Central Coast Region, South-Central Coast Region, and South Coast Region). This framework advocates establishing the biogeographic region as the primary scale for adaptive management analyses and decision- making on recommendations to forward to the Fish and Game Commission for consideration and possible action. The MLPA Blue Ribbon Task Force adopted a recommendation to endorse the concept of two biogeographic regions within state waters, divided at Ppoint Conception. The SAT agreed that this was the strongest biogeographic divide within California, but discussed other biogeographic regional divides, with most judgments supporting identification of three to five bioregions in state marine environments.

Adopting the two-biogeographic region concept for adaptive management has many advantages. It:

- Corresponds to a significant unit of scale used by scientists (and underlying natural phenomenon);
- Matches the legal requirements of networks of MPAs within bioregions;
- Results in a limited number of arenas for information aggregation and decision-making;
- Is consistent with the use of four smaller regions that corresponds with a committee structure and process outlined in the California Nearshore Fisheries Management Plan.

The disadvantages of the biogeographic region include:

- It encompasses significant distances, which can encourage data-driven discussion removed from “ground truthing” in actual experiences.

Structures for Scientific Advice, Stakeholder Involvement, and Public Participation

Two approaches have been taken to develop structures of bodies/groups for scientific advice and stakeholder involvement in MPA policy making in California, and at least one other model exists elsewhere (see Appendix 1 Case Studies on Existing MPA Monitoring and Evaluation). Public involvement is often expected to occur through formal public meetings (such as those of the California Fish and Game Commission), though explicit provisions have been made for public involvement in California and elsewhere. Three approaches to structures for scientific advice and stakeholder involvement are:

1) Scientists and stakeholders in one advisory structure (the Channel Islands model and also that of Monitor National Marine Sanctuary (MNMS) and other National Oceanic and Atmospheric Administration (NOAA) sanctuaries)

2) Scientists and stakeholders in separate groups, providing input to a seasoned group of policymakers (the MLPA Initiative model with BRTF, SAT, and CCRSG)
3) A stakeholder group as the key body to which scientists and technical staff provide support (The Grand Canyon Ecosystem Adaptive Management Program)

The structure most appropriate for the MLPA is structure (1) because effective adaptive management occurs over long time periods and will benefit from participation by individuals who either have or can gain deep familiarity with the issues to be understood and the implications of choices confronted. This suggest the model (1) is appropriate for adaptive management, as continued attention is most likely needed only from stakeholders or interested scientists to provide recommendations to policymakers.

The MLPA Initiative process has been characterized by extensive opportunities for public participation, including web posting of draft work products for review and comment, open meetings (most with public comment periods), webcasting and/or web-archiving of all meetings of the BRTF, CCRSG, and SAT, creation of a statewide interest group (consisting of stakeholder representatives) to design and monitor public participation, and extensive staff communication with individuals and groups.

Experience with fisheries management policy making is at least as important a base upon which to build as is the experience with protected areas. Many stakeholders who will be involved with adaptive management under the MLPA will bring experience in fisheries management arenas. Many others will participate in those processes at the same time that they participate in MLPA processes. The two relevant experiences are those of the Pacific Fishery Management Council and of the Nearshore Fishery Management Plan Committee for the State of California, especially regarding nearshore fishery (for a full description see Appendix 4 and 5).

TENTATIVE RECOMMENDATION WHICH MAY CHANGE Because of its familiarity in California and in the national marine sanctuaries, this framework recommends the creation of a body consisting of both stakeholders and scientists to guide adaptive management under the MLPA. This group would be named the “Adaptive Management Council for _____ Biogeographical Region.” Appointments to the body would be made by _____.

The roles of this group would include: **THESE ROLES WOULD NOT CHANGE**

1) Identifying the questions which are to be addressed by science to support adaptive management, including questions relevant to natural systems, human systems, and management actions pursuant to approved networks of MPAs.
2) Approving the design of monitoring and evaluation efforts to address the identified questions.

3) Prioritize monitoring implementation of the approved network of MPAs[2] and implementation of the monitoring and evaluation efforts.
4) On a regularly scheduled basis established when the network of MPAs is created, but no less frequently than every five years (although is many take longer than 5 years to see significant changes), complete a systematic review of performance of the network of MPAs within each biogeographic region and a review of the performance of individual MPAs for (a) their contribution to the network, and (b) against the objectives specified for that MPA.
5) Based on the judgments reached in these reviews, the MLPA Adaptive Management Council (AMC) would develop recommendations in one or more of the following areas: (a) changes in management operations of individual MPAs within their current designation, such as a shift in enforcement or education activities, (b) changes in the boundaries or regulations of individual MPAs intended to better achieve network goals or the objectives of the individual MPA, (c) the abolition of an existing MPA, (d) creation of a new MPA, or (e) change in the goals being pursued with a network of MPAs.

The AMCs need to meet regularly to establish effective working relationships and to master their complex roles. The work load of adaptive management councils will vary according to the roles they perform. It is likely to be high during the initial phase of identifying researchable questions and approving monitoring and evaluation program, then less during monitoring of implementation, and increasing again when considering possible changes to MPAs, goals, or objectives under the regularly scheduled adaptive management cycle. Given the variation in work load, it is reasonable to expect the need to meet will vary also, probably requiring two meetings per year in the periods of lighter work load and four meetings per year during heavier work loads.

As the geographical range encompassed by AMCs will be large, the councils may consider establishing sub regional councils to assist the Adaptive Management Councils. These groups would probably be busiest in the adaptive management cycle.

The California Department of Fish and Game (CDFG) currently coordinates or recently coordinated (some are no longer active) a total of 15 advisory committees (see Appendix 6 for the complete list with description of composition and function). In 2006 the CDFG will create the Nearshore Advisory Committee (NAC). We recommend combining the MLPA adaptive management councils with the NAC for three reasons. First, the CDFG has limited resources, and managing all of these committees takes time and money. Second, the NAC has not yet been created and will advise on similar issues to those proposed by MLPA AMCs. The purpose of the NAC overlaps well with the goals of the MLPA. Finally, the NAC will be established within the timeline that works for the MLPA.

The CDFG is currently working with a consultant to develop the most useful "self-sufficient" regional advisory committees. Due to the concerns over the number of existing committees and advisory groups and costs involved in operating them, the CDFG is reviewing what

[2] Not all MPAs are required to be monitored under the MLPA (section 2853 (c)(3).

committees and groups currently exist, looking for overlaps, and determining what structures and processes are working well. In the next few months CDFG will lay out a plan describing how to create the NACs that will meet CDFG expectations and needs. This process will involve key stakeholders in the design process. This will ensure that the NACs are designed to best meet user needs. The plan for the NACs will be completed by spring 2006, and at least one regional meeting will occur before the end of June 2006. During the first meeting CDFG will be conducting an "in process training" for the involved staff, so that they can then proceed to initiate meetings in the other regions. A main goal of the NACs is to identify and develop regional priorities.

Roles in the MLPA Adaptive Management Processes

Table 2 identifies roles and Figure 4 describes the process in adaptive management under the MLPA that are recommended in this framework. The institutional choices follow the recommendations made above.

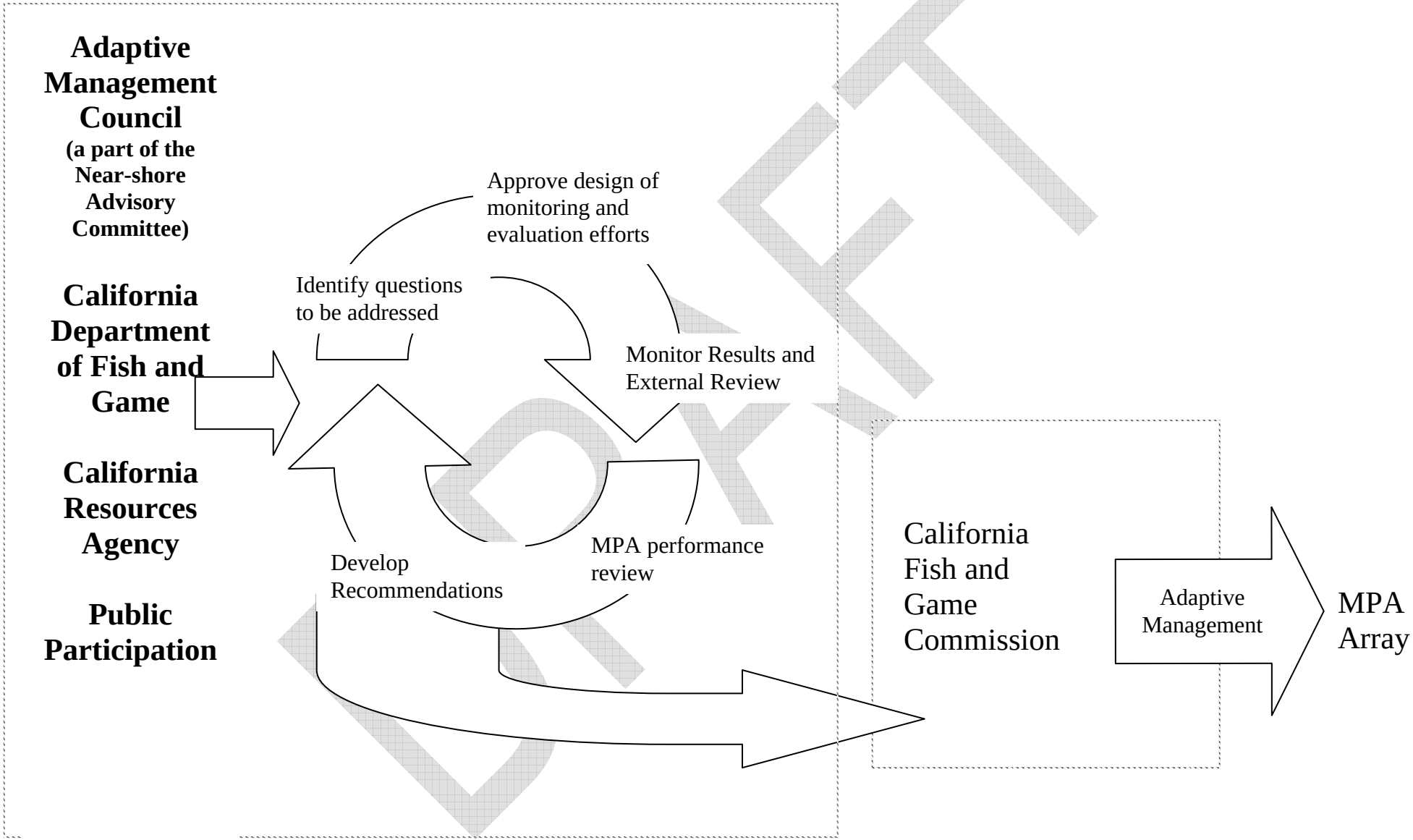
Table 2: Institutional Roles in MLPA Adaptive Management Processes

	Identify researchable questions re. adaptive management	Design monitoring and evaluation program	Implement network of MPAs and monitoring and evaluation program	Monitor MLPA implementation and monitoring and evaluation program	Adaptive management review and recommendations
Fish and Game Commission	D	D	NR	NR	D
CDFG/ California Resources Agency	T	T	M	A	T
Adaptive Management Council	R	R	NR	R	R
External Researchers	A	A	NR	A	A
Peer reviewers	A	A	NR	NR	A

Key:

Analyze and provide report	=	A
Authoritative decision	=	D
Operational management	=	M
Recommend (initial)	=	R
Transmit, with recommendation	=	T
No role	=	NR

Figure 4: Adaptive Management Process Design



Capacities and Incentives

As noted above, adaptive management poses untold challenges. To succeed, sufficient capacity must be present in all of the participating organizations to fulfill their roles. Additionally, incentives must be present to actually "do" adaptive management.

The danger of lack of capacity and incentives is well illustrated in the Northern Coast Range Adaptive Management Area adopted in 1994, encompassing 113,000 hectares of federal land in the Coast Range of Oregon. The forest lands are administered by the U.S. Forest Service and the Bureau of Land Management, with intermixed and surrounding forest lands owned by industrial forest products companies (Gray 2000). Approximately 2/3 of this area was designated as "forest reserves" to protect old growth habitats favored by the endangered marbled murrelet and spotted grey owl. Additional reserves were established in riparian areas of perennial and intermittent streams. Various groups were established to participate in the adaptive management process, and a multi-stakeholder "Coast Range Provincial Advisory Committee" was established to provide recommendations to federal land managers (Gray 2000: 5).

Gray (2000: 16-17) identifies specific factors that contributed to the lack of effective adaptive management in Oregon's Coast Range region:

1) Uncertainty and conflict over the scale ("landscape," watershed, whole area) at which adaptive management decisions were to be made.
2) Tendency to prescribe solutions rather than identifying uncertainties and opportunities to pursue different alternatives as a way to learn.
3) Declining financial resources to key implementing organizations.
4) Lack of flexibility in organizational programs.
5) Tendency to limit choices considered to avoid prior battles.
6) No one (a single organization or profession) "owned" adaptive management.
7) No effective way was found to manage the inherent complexity of hundreds of species, ecosystem functions, and multiple spatial and temporal scales.

Gray (2000: 18) suggests the following, which relates to institutional capacity and incentives, as ways to improve adaptive management in this case:

"Greater efforts to institutionalize adaptive management may help ... though it is difficult to develop the type of interactions and rewards that keep managers, researchers and citizens involved in long-term efforts. Introducing adaptive management as a component of job descriptions, project design, reporting requirements, and training programs may help. Providing rewards and recognition for the researchers and citizens involved … could also be important. It might also be advisable to formalize interagency commitments to support adaptive management under the NWFP and to accept some local risks, even to endangered species."

The extraordinary impact of Gray's point is that, with the possible exception of local risks to endangered species, all these suggestions are standard management prescriptions for achieving any long-term goal. Without appropriate project design, interagency commitments, job descriptions, and rewards, NO policy will succeed.

Chornesky (2005: 9-14) draws similar lessons from a review of case studies related to adaptive management. She does not address the institutional context within which recommended decisions about adaptive management will be made, but her "lessons" focused on monitoring to support such decisions follow similar logic. Those lessons are:

1) Create value and impact by directly linking monitoring to resource decision-making and ensuring that data are highly credible.
2) Ensure longevity by formalizing accountability of the participants and by developing sustained funding streams.
3) Make things happen with dedicated capacity and institutional autonomy.
4) Start out with an integrated information system.
5) Maximize data access, analysis, and reporting to support public processes.
6) Plan for change.

While multiple actors, public, private and non profit, are very likely to be involved in successful adaptive management and monitoring and evaluation, the responsible agencies of the State of California must have sufficient organizational capacity, incentives, and political support to perform their critical roles. The CDFG is the lead agency in implementing the MLPA, and the California Fish and Game Commission is responsible for formal policy making, including any changes made through adaptive management processes. Ensuring sufficient capacity, incentives, and political support for these two organizations will be critical to success. The CDFG only has a few individuals deeply knowledgeable about the MLPA and budgeted funds for marine activities generally have ebbed and flowed over the past decade (ref). The California Fish and Game Commission relies on the CDFG and public inputs for information. Perhaps more positively, the CDFG has substantial and growing experience with terrestrial habitat conservation policies and programs, much accumulated under the Natural Communities Conservation Plan approach to comply with species protection policies. Here the CDFG not only developed internal staff competencies, but also developed effective partnerships, especially with regional councils of governments (e.g., San Diego Association of Governments).

2D. Monitoring and Evaluation and Research

Monitoring

Monitoring improves our understanding of the natural and human dynamics of the marine environment and forms a critical part of effective management and scientific research. It is essential to monitor changes that are caused by human activities for improved management of natural resources to ensure the sustainable use and conservation of marine ecosystems.

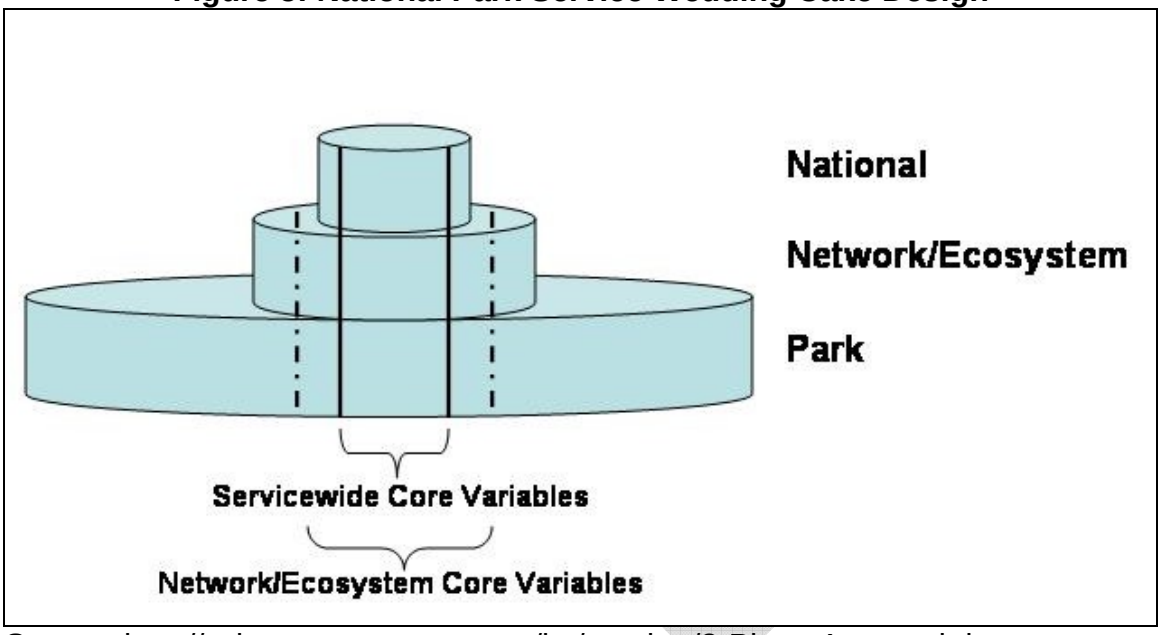
Generally three types of monitoring exist: monitoring the ecological health of the environment; monitoring to detect change; and compliance monitoring (Australia's Reef Futures website: http://www.reeffutures.org/topics/monitoring/why.cfm). Chornesky (2005) describes how monitoring plays a critical role in adaptive management because it allows managers and interested parties to:

- Evaluate the impacts of specific management choices;
- Build knowledge about the managed ecosystem and thereby improve future management decisions;
- Identify emerging threats; and,
- Determine the extent to which the ecological and/or socioeconomic management goals for the ecosystem are being met.
- The link between monitoring and decision-making is important in order to improve policy and management decisions and also to create a demand for monitoring and thus financial support. It is essential that ME&AMF includes some monitoring capacity focused on developing and communicating information about status, trends, and performance of individual MPAs and MPA arrays (Chornesky, 2005).

The indicators that will be selected to monitor throughout the MLPA may follow the "wedding cake design" used by the National Park Service and adapted from the USDA Forest Service. Indicators will be needed at three levels (see figure 5). At the park level, site specific data will be needed by resource managers and other stakeholders to make management decisions. The network/ecosystem level (in the MLPA the equivalent is the biogeographic region) will also have a set of indicators that are monitored in a standardized way to allow for larger area comparisons and synthesis of data. At the national level (in the MLPA the equivalent is the statewide), again a set of indicators will be monitored. For the MLPA, a select group of MPAs can be monitored for the ME&AMF (Section 2853 (c)(3) of the MLPA). However, developing a network monitoring program with control areas outside of MPAs is complex. It will require heavy investment in planning and design to guarantee it meets the needs of the MLPA and each park, and it must be scientifically credible and accepted by stakeholders. It is crucial to solicit stakeholders' participation in deciding which indicators to monitor at all levels.

Once a monitoring and evaluation report is developed, a core list of indicators will be established for the state and each region. This list will be guided by the statewide adaptive management questions, the statewide goals, and the regional goals and objectives. The list will prioritize goals and objectives, and then translate them into measurable questions to be measured with indicators. Individual MPAs will have a menu of indicators, but not all indicators will be measured in each MPA. As these data are collected, results will be analyzed to determine relative change. Further review of these results will be used to evaluate whether or not the MLPA is effective in achieving the goals and objectives at both the region and state level (for more information on indicators see Section 4B and illustrative Table 4 for central coast).

Figure 5: National Park Service Wedding Cake Design



Source: http://science.nature.nps.gov/im/monitor/3-PhaseApproach.htm [National Park Service Inventory and Monitoring website]

Role of Research in the ME&AMF Framework

Research is important to enhance the ME&AMF process, and it is an important way to support the adaptive management of ecosystems at the biogeographical scale. Given the size and scope of MPAs and the MPA array, it is sometimes necessary to conduct separate research activities aimed at achieving better understanding of the underlying biological, chemical, or physical phenomena and human dimensions relevant to particular MPAs or an MPA network. Overlap and feedback naturally occur between the research and monitoring discussed above. For example, information about the status of some element of a particular ecosystem may raise questions that can only be addressed through a program of focused research. Alternatively, focused research will almost certainly make use of the datasets collected through the status and trends monitoring. Scarce financial resources require that research activities be prioritized. Priority research questions should always be motivated by the needs of decision-makers and stakeholders.

The process employed by the Great Barrier Reef Marine Park Authority to determine research priorities for the Great Barrier Reef Marine Park provides a blueprint for how such priorities might be set in the MLPA and revisited over time (GBRMPA 2001).

The GBRMPA invited representatives from government agencies, scientists with extensive knowledge of the Great Barrier Reef and its management issues, scientists from relevant fields, and other stakeholders to participate in a series of interactive workshops. These workshops exclusively focused on determining high priority management issues, the

information needs required to address those issues, and the specific research tasks that would address those needs. When the list of high priority research tasks was complete, the highest priority tasks were identified. A similar process is recommended for the MLPA, whereby research priorities can be identified through a facilitated, interactive consultation with resource managers, scientists, and stakeholder groups, many of whom are already participating in MLPA design discussions.

The GBRMPA periodically updates its research priorities based on emerging issues and the results of ongoing research and monitoring. The process and outcomes for a recent review of the GBRMPA research priorities are described in detail in "Australian Government GBRMPA 2005, Research Needs for Protection and Management of The Great Barrier Reef Marine Park 2005," but a similar consultative approach involving previously mentioned participants is used. During the update in 2005, the key research issues considered included importance to the protection of the Great Barrier Reef; national research priorities; legislative and policy imperatives; community interest; and relative urgency (GBRMPA 2005). This review process resulted in the identification of 274 research questions, 21 of which were considered critical in importance.

Below is a brief description of three types of research relevant to the MLPA. The first and second categories of research described below are the highest priorities and will be embedded in the monitoring and evaluation regional plan. The scientists on the AMC should identify key science needs, which then need to be incorporated into the operational plan. The third research area is important, but would not be supported by the ME&AMF plan. Instead, it would be supported through partnerships and outside funds. Implementation of the ME&AMF should motivate and provide resources and infrastructure to encourage scientists to conduct of studies. Data from monitoring needs to be available to researchers to advance knowledge. Furthermore, in the MLPA Central Coast Project, for example, one of the objectives requires the MLPA to develop collaborative scientific monitoring and research projects evaluating MPAs that link with fisheries management information needs, classroom science curricula, volunteer dive programs, and fishermen of all ages. The research areas listed below relating to MPA monitoring, evaluation, and adaptive management, specifically categories 2 and 3, could be the focus for helping achieve this objective.

<u>1) Research applied to evaluate if MPAs are effective in achieving objectives</u>: In this category, there are two kinds of studies: (a) monitoring inside and outside of MPAs, and (b) occasional process-related studies that help explain patterns shown by monitoring work under (a). For example, if nearshore rockfish increased in density (an increase inside MPA compared to outside), a process study would be required to show how to interpret monitoring data. The purpose of this study might be to answer any number of questions: What is the necessary density of nearshore rockfish to reproduce? What is the larval dispersal distance? Is there evidence of spillover? etc. These process studies are needed to help interpret monitoring data related to effectiveness. The ME&AMF AMC and staff could either generate from the beginning what sort of process study needs exist or decide as the plan is implemented and preliminary results presented.

2) Research applied to test MPA effectiveness by decoupling natural and human changes: This line of research would test whether or not MPAs are an effective management tool by designing and employing studies that decouple natural change from fishing pressure-induced changes. As mentioned above this type of monitoring and research will be necessary to evaluate the effectiveness of the MPAs and therefore will be in embedded into the implementation of the ME&AMF.

3) Research studies of natural ecosystems that are not being influenced by fishing and other effects: These types of studies are important but the lowest research priority for the ME&AMF. Examples may include biophysics of marine larval dispersal, interaction of marine viruses on various biogeochemical processes--e.g. nutrient cycling, rate of sedimentation, etc

The MLPA is challenged by the immense spatial scope of the MPA array as well as the diversity of entities that will be conducting research and monitoring. In several of the monitoring case studies analyzed by Chornesky (2005), one or more committees have been structured to facilitate the links between data and decision-making. When linking research and policy in this way, it is important to keep the policy-focused questions developed by policy makers and stakeholders in mind. At the same time, it is necessary to ensure that particular interests or sub goals impede neither the types of questions the research is designed to answer nor the monitoring process. The challenge of orchestrating the cooperation of the multiple organizations represented on these committees can be accomplished through the creation of new, staffed, independent, operating units with the "**singular purpose and dedicated capacity** to allow the partnership to move forward" with coordinating monitoring and research, managing data, translating results for different target audiences and adaptive management (Chornesky, 2005;13). Examples of such organizations include Southern California Coastal Water Research Project Authority, South Bay Salt Ponds Restoration, Central California Joint Ventures, and Puget Sounds Water Quality Management Plan. In this way, ensuring the operational relationship between research and monitoring and guaranteeing that both serve the needs of decision-makers are key mandates of the independent operating unit.

Permits

The MLPA adaptive management councils need to devise a mechanism for frequent review of applications for research permits that involve take, in conjunction with the Department of Fish and Game's scientific permitting process (Carr *et. al.* 2005). Priority should go towards research that will contribute to MPA evaluation and ecosystem-wide effects, projects involving local stakeholders, and existing research programs with historical data. In addition, using universal methods and formatting data in compatible structure for data management is essential. It is recommended that the CDFG consider tying the data ownership to the permitting process and require delivery of data to the monitoring program.

3. Statewide Oversight and Management for ME&AMF Implementation

There are many ways set up the infrastructure for monitoring, evaluation, and adaptive management implementation. However, it is a challenge to orchestrate the cooperation of the multiple organizations involved in the MLPA. Based upon interviews with SAT members, the MLPA Initiative staff, and relevant reports it is recommended that the creation of new, staffed, independent, operating unit is created to move partnerships forward in coordinating research and monitoring, and integrating the results of both into MLPA adaptive management. Some MPAs that have not "provided the explicit mandate, resources and capacity for coordinating monitoring activities" have failed to ensure that key scientific information would be available to inform decision-making (Chornesky, 2005;13). The new operating unit can either be a new agency or entity with a focused mandate and staffing.

A predictable funding stream and dedicated capacity and leadership are vital for implementing major portions of the monitoring plan and for promoting sustained implementation. Creating mechanisms of accountability for partners and participants as well as long-term sustainable financing will help ensure the long-term success of the MLPA ME&AMF. This formalization can take place in two ways: 1) multiple agencies or organizations may enter into a statutory or voluntary agreement, or 2) partner institutions or individual scientists may receive grants or contracts for agreed upon work. However, the structure established to coordinate monitoring, evaluation, and adaptive management must provide transparency of the ME&AMF process outlined.

The organization responsible for implementation and oversight of the ME&AMF will need to oversee and take responsibility for the coordination and execution of the following activities:

Monitoring*:* The primary purpose of this activity is to ensure that data of sufficient quality and quantity are collected to support assessment of goals and adaptive management of the MLPA. Execution of monitoring activity will consist of budgeting, contracting, and coordinating monitoring activities conducted by public and private entities as well as volunteers. This function will also involve coordinating scientific peer review of collected data and ensuring that standard methods and procedures are used statewide.

Research: The primary purpose of this activity is to coordinate the research conducted by various institutions to support ongoing assessment and adaptive management of the MLPA system. The work will consist of budgeting, contracting with research institutions, and coordinating with managers and researchers to ensure that the research needs of management are met through the research efforts. This function will also involve coordinating scientific peer review of research results.

Data Management: The primary purpose of this activity is to coordinate the design, management, and maintenance of the statewide information system to house MLPA data. This will involve budgeting and contracting for laboratory and data management services, managing public access to data, and coordinating quality assurance/quality control.

Managing Committees: The primary purpose of managing the variety of committees formed through the MLPA is to ensure transparency and efficient, effective conduct of committee work. This will involve developing guidelines and mandates for committees, ensuring adequate representation and participation by stakeholders, facilitating communication among various committees, agency staff, and the legislature, as well as providing for necessary facilitation services and meeting equipment and arranging venues for in-person committee meetings.

Reporting (evaluation of progress and goals, as well as recommendations for adaptive management): This activity involves coordinating scientific review of monitoring and research products and developing recommendations for additional monitoring and research needs as well as proposed adaptive management response. Recommendations regarding monitoring needs and recommended adaptive management responses will then be communicated to legislature and/or responsible state agencies.

Communications: The primary purpose of this activity is to develop and publish all electronic and print materials in order to communicate MLPA results and processes to MLPA participants, the general public, and government representatives. This will require organizing conferences and stakeholder meetings, developing, managing and maintaining internet materials, publishing print materials, and coordinating communication among stakeholders, agency staff, and the legislature.

Based upon the responsibilities listed above, below are three scenarios for a statewide implementing institution:

1) California Department of Fish and Game is responsible for implementation and funding of the monitoring, evaluation, and adaptive plan. However, funding must be allocated and secured specifically for this project to ensure success.
2) Sea Grant or a similar type of institution establishes a memorandum of understanding (MOU) between Sea Grant and California Resources Agency by which Sea Grant would be responsible for the implementation of the plan. The institution would still need to report to the State Agency, the California Department of Fish and Game.
3) Establish and fund a consortium at a university such as University California at Santa Cruz or Santa Barbara by a foundation. There needs to be an MOU between the consortium and California Resources Agency by which the consortium would be ultimately responsible for the implementation of the plan. The institution would still need to report to the State Agency, the CDFG.

It is important that this implementing entity be flexible because questions, data, and monitoring and research needs will constantly change. It is also important that if scenario 2 or 3 is selected that the CDFG assigns a staff person in each region to coordinate with the university consortium or foundation.

In each of these scenarios the chosen institution would be coordinating subcontractors. The staffing of the organization will focus on science, information and technology, and communications, with a minimum of two administrative leadership positions. Staffing skills

include quality control/quality assurance of data, data management, spatial data, website management, and communications.

It is estimated that a minimum of 15 staff will be required to ensure effective delivery or the framework and regional plans. In addition, the leadership needs to have interdisciplinary marine resource management backgrounds in order to oversee the coordinated monitoring program and communication of the program. The project leader will report to both the CDFG and the Adaptive Management Councils and entity for which he or she works. Furthermore, the organization may consider having a steering committee of experts, with no invested interest, to advise its members on a wide range of topics, from communications to data management.

MLPA staff prepared a comprehensive strategy for long-term funding of MLPA implementation in December 2005 for the BRTF. Estimates for annual costs will be approximately $XX for implementing the ME&AMF.

3A. Research Design and Methods

The research design of the monitoring, evaluation, and adaptive management program for an array of MPAs of this size is extremely complex and confronts a number of issues.

There are many ways to set up of the research design to collect biological, physical, and socio-economic data for the ME&AMF. Below are listed four main approaches in the location of monitoring sites:

1) A Statewide Survey: Statewide monitoring randomly or purposely stratified could provide robust results since it would eliminate the challenge of finding appropriate reference sites. However, since a statewide survey could involve considerably more resources than monitoring only localized areas.
2) Within MPAs: This monitoring will provide information on the state of protected resources and ecosystems.
3) Inside MPAs vs. Outside MPAs: This approach will compare and contrast conditions over time. Inferences could be made on differences between MPAs. It is very important to have comparable sites as well as and fishing activities.
4) Multiple MPAs and Controls: This approach will allow provide inferences on general MPA effects, influence of MPA environmental design features, and predict effectiveness. Pairs of MPAs are selected inside and outside MPAs across a range.

In addition to location of monitoring, the timing of monitoring is also an important factor and must be considered. Below are the two main approaches:

1) After-Control-Impact (ACI): If it is not possible to collect data prior to MPA establishment or at implementation, it can be collected intensively during the first year, as was done in the Channel Islands. Comparing data from inside and outside the MPAs can provide insight into how the establishment of the MPAs has affected

the trajectories, trends and patterns of two systems over time and the sites are changing in predicted ways.

2) The Before-After-Control-Impact (BACI): BACI can provide information on the effectiveness of MPAs at protecting species targeted for exploitation (Syms and Carr, 2001). BACI is more common than IVRS and requires that reference sites (to which MPAs will be compared) be as similar as possible to MPAs. Although these sites are often challenging to find, BACI is based on the model that temporal differences in sites are attributable to MPA effects and therefore can make site specific statements about MPA effectiveness (Syms and Carr, 2001). There is a rich literature on BACI designs (Steward-Oaten and Murdoch, 1986; Stewart-Oaten and Bence, 2001; Schroeter *et. al*., 2001).
    a. The Impact vs. Reference Site (IVRS): This approach uses before and after data for MPA comparisons. This approach assumes that the MPA and non-MPA sampled areas are independent, formally randomized experimental replicates, and therefore sites are randomly assigned to controls or MPAs. This approach requires that sites (either in MPAs or control areas) are independent (do not affect each other), but this condition of independence is often difficult in reality to maintain (Syms and Carr, 2001).

Based upon the timing of MLPA implementation and the MPA site selections, different approaches may work for different indicators and areas. BACI and IVRS approaches will most likely not be effective in the Central Coast, where MPAs will be established in the near future. Since collecting data before MPA establishment is not likely to be possible. It is then recommended to have an intensive sampling effort, ACI, start immediately upon establishment of the MPAs such that it can reasonably be assumed that the differences owing to protection will not be seen immediately, as in the case of Channel Islands when the MPA went into effect and data was immediately collected. The data from this intensive sampling effort could serve as a baseline against which to measure subsequent temporal trends that develop as the MPAs mature.

A rich literature on research design can be reviewed once the questions and indicators are selected. It is recommended that the scientists on the AMC suggests the general nature of the sampling design, especially in view of the availability of pre-establishment monitoring data relevant to selected indicators. Finally, although the MLPA (Section 2853 (c)(3)) and scientists may not require monitoring in every site it may be necessary for adaptive management and policy purposes.

Control Sites and Replicates

A number of additional challenges are associated with ensuring that sufficient data are collected to satisfy the primary purpose of a monitoring program. The primary purpose of collecting data inside and outside of MPAs is to make statements about differences between these two types of areas as related to the increased protection afforded by the MPA. Willis et al. (2003) critically evaluated experimental designs employed in published studies related

specifically to reserves (one type of MPA) and identified problems with replication and lack of control sites:

- Only one site sampled inside and outside a reserve, or no control sites sampled at all (insufficient sample replication)
- All control sites located only at one end of the reserve (spatial confounding)
- Surveys only done at one time (lack of temporal replication)
- Not enough reserves sampled
- Reserves are often sited to include special or unique features so finding controls is difficult (Willis et al. 2003).

These problems can affect the ability to determine whether or not differences between control sites and MPAs exist. Willis et al. acknowledged that some of these problems are unavoidable due to the nature of the reserve system. However, we all know it is unlikely to find the perfect controls and replicate sites. Ideally, control sites should be located in order to balance competing priorities regarding proximity to the protected areas to which they will be compared. Control sites should not be so close to the protected area that their biological features are enhanced because of the protected area. However, the scientists must also consider that sites not be so far away that the conditions and habitats do not match (Gell and Roberts, 2003). It is recommended that the scientists on the AMC suggest criteria for control sites and replicates and review the list of locations once determined. The implementing entity will need to allocate enough planning time and resources to make possible the implementation of rigorous survey designs and intensive baseline data collection.

Spatial and Temporal Considerations of Research Design

When applied to monitoring, collecting, and analyzing data, the issue of spatial and temporal scale can be quite complex. We need to understand, if possible, the trends and patterns of the indicator being measured because a number of spatial and temporal factors can influence data collection and analysis. For example, behavioral patterns, migration, and mobility of species can change annually or seasonally. Syms and Carr (2001) explain that some parameters may be restricted to within the boundary of the MPA, such as increased larval production, and others may be manifested over a greater spatial expanse, such as larval dispersal to and replenishment of fish populations outside an MPA. Furthermore, natural spatial variability can confound control effects if the parameter of interest is not similar prior to the effect that is being measured (Osenberg and Schmitt, 1996). When selecting controls, pairs of geographically adjacent sites can minimize this spatial variation (Tissot and Hallacher, 2003). When conducting meta-data analysis, variability among the sizes of MPAs or reserves may need to be taken into account.

Ideally, we should have data or at least a conceptual model of relevant temporal trends and patterns of indicators before determining how to monitor. For example, some oceanographic conditions and behavioral patterns occur annually or seasonally. Syms and Carr give the example that some parameters may respond quickly after MPA establishment, such as change

in population size structure of a fast growing species within a MPA, while others may take many years, such as the increased recruitment of a slow-growing species into a catchable stock outside the MPA. Different indicators need to be monitored at different time intervals. For example:

- Data measuring the recovery, measured as the proportion of the total MPA area or focal species population (abundance, biomass, or % of total pop.) that has experienced or "been restored" to assumed original target levels of either community composition, natural conditions, or viable populations levels and stock integrity, could be measured between every two to five years (Pomeroy *et. al.*, 2004).
- Survey data measuring the "perception of seafood availability" should be asked for the same time period every (season, month) of every year (Pomeroy *et. al.*, 2004).
- Survey data measuring the "local understanding" of the MPA rules and regulations can be collected at the start of the project and every year after (Pomeroy *et. al.*, 2004).

Gerber et al. developed a model to answer the question, "How long should we monitor the recovery of an over-fished stock to determine the fraction of that stock to reserve?" This model was for a single species fishery, and did not take into account interactions between species or the targeting of more valuable fish species. It may be problematic to apply to large habitat patches where larval spread may be less efficient in fished areas. Furthermore, Gerber et al. assumed that larval recruitment includes settlement and survival to legal size adults within the period between settlement and fishing. They found that the long-term benefit for monitoring was maximized between three and seven years, with a discounting rate of 1%, depending on the precision of monitoring (Gerber *et. al.*, 2005). They also found that the long-term profit decreased with the size of the reserve area; however, size was only one factor for monitoring methods with low accuracy (Gerber *et. al.*, 2005). Their model showed optimal monitoring to be three to seven years; some managers around the world also recommend this time frame (Gerber *et. al*, 2005). However, most marine management organizations recommend indefinite monitoring (Pomeroy *et. al.*, 2004).

Table 3 describes the tasks and related time frames at which they may need to occur. Data collection at the individual MPA will be intense and occur seasonally, whereas these tasks will take place annually at the MPA array and regional scale. Review and adaptive management will occur less frequently as the scale increases. We recommend that the adaptive management process be divided into four regions following the boundaries outlines in the California Nearshore Fisheries Management Plan (North Coast Region, North-Central Coast Region, South-Central Coast Region, and South Coast Region).

We recommend that once the indicators are determined, the scientists on the AMC should help determine at what spatial and temporal scale these data should be collected depending on sensitivity of indictors. Furthermore, we recommend intensive data collection of all indicators at all sites Year 1 to collect a baseline, and then again in the future, perhaps year 7 or 10.

Table 3: Table of Scale and Temporal Comparison for Adaptive Management and Operations

Task	Individual MPA	MPA Array	Region
Data Collection	Seasonally	Annual - Biological Annual - Social	Multi-year - Biological Annual - Social
Data Review	Annual	Multi-year	Decadal
Operational Changes	Seasonal	Annual	Annual
Adaptive Management	Decadal - Biological Annual - Social	Decadal - Biological Multi-year - Social	Multi-decade - Biological Multi-year - Social

Stakeholders such as fishers may have knowledge to incorporate. In between the years of intensive data collection, a smaller subset of sites would collect each indicator; again the location of data collection would be determined by the scientists on the AMC.

Statewide Universal Methods and Data Management Requirements

All grantees, subcontractors, or partners given funds to collect data will be required to use methods explained in detail in the *Monitoring and Evaluation Report*. Furthermore, data must be provided in a format and in software compatible for data management.

3B. Quality Assurance and Quality Control

A monitoring effort of this magnitude will address challenges associated with data quality assurance and control. It is critical to establish processes, such as external review, that ensure quality assurance and control. Furthermore, credibility is critical because ultimately these data will inform public processes that must stand up to scientific peer review, legal review, and public opinion (Chornesky, 2005).

Data could be collected by many different types of programs and entities such as staff of the organization implementing the ME & AMF, CDFG, and other monitoring programs (Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO), consultants, volunteers, university researchers, etc.). All of these data must be integrated into the MLPA data management structure because it is critical to ensure data quality control and intercomparability across different programs.

For the volunteer monitoring, an added challenge exists of stimulating stewardship of marine resources through participation in the monitoring efforts while, at the same time, establishing a protocol framework sufficiently rigorous to produce useful data. The Surface Water Ambient Monitoring Program (SWAMP) was proposed in a report to the California Legislature to integrate existing water quality monitoring activities of the State Water Resources Control

Board (SWRCB) and the Regional Water Quality Control Boards, and to coordinate with other monitoring programs (SWRCB 2005a). SWRCB addressed the challenge of ensuring data quality and intercomparability by undertaking an intensive effort to define systematic data collection and analysis protocols, data quality objectives, procedures for data storage and management, and many other factors that all participants were trained on and abided by. Learning from this experience, it essential to communicate and implement standardized, universal methods of data collection and storage. The Great Barrier Reef Marine Park Authority has also been successful in this effort (Day, 2002). Many MPAs focus on documenting standardized monitoring procedures and requirements and making this information easily available online (Chornesky, 2005; 2). Such documentation helps ensure that results can be compared across multiple spatial scales, which is essential for assessing progress for a statewide program.

The scientists on the AMC will recommend what methods, data formats, etc. will be used for each indicator. This will be explained in *Monitoring and Evaluation Report*. Furthermore, if grantees, subcontractors, or partners are funded to collect data, they should be required to use methods approved by the MLPA M&E process. Such requirements could also be set forth in permits issued by CDFG, for example.

In summary, to ensure the credibility and acceptance of results by decision-makers and stakeholders, data need to receive external scientific review (Pomeroy *et. al*, 2004). The AMC, based on its members insights and experiences, will provide recommendations for ways in which external review can be accomplished effectively. Peer review of results is important, but so is going through a scientific process to strategically set the course for the ME&AMF. External reviewers need to be unbiased and disinterested parties. CDFG already has a peer review process in place that could be used or built upon. This review should include consideration of methods and their implementation, quality control/assurance procedures, and, of course, data results.

3C. Data Management

Developing an integrated information system concurrent with implementing a network component of MPAs which will be adopted by the Fish and Game Commission can increase and improve data analysis and synthesis as well as the use of data by policymakers and managers to make decisions. Based on case studies, Chornesky (2005) found that data management and monitoring plan assembled post hoc with disparate data sets can be difficult and sometimes impossible to analyze in order to create an effective, credible system.

Developing an overarching strategy for managing, archiving, and communicating monitoring data can help avoid inefficiencies in conducting data synthesis and dissemination to interested parties to support public processes. This strategy can also provide a framework for the future needs and outline the structure, equipment, human and financial needs to implement. Further, an integrated information system should be developed at the statewide scale that enables access to data, provides long-term data archiving, establishes data management standards, and institutionalizes data access policies.

3D. Communication of Process and Results

Data, progress, and results of the ME&AMF need to be communicated with all policymakers, mangers, stakeholders, and scientists since the main purpose is to communicate information on MPA or MPA array trends, status, and performance to improve policy and practice. Audiences include scientists, government staff, policymakers, and Central Coast consumptive users, non-consumptive users, local and private businesses, and the public. Research shows that contentious public processes can be eased with broadly accessible monitoring results (Chornesky, 2005). Given the multiple audiences, we recommend not only creating reports for the scientific community and government staff, but also translating the more scientific findings to make them accessible to policymakers and local stakeholders. Reports and data also need to be made accessible to the public via the web. The MPA array monitoring program should have websites that would include information relevant to the ME&AMF such as access to databases, technical papers etc. and also public education materials.

Contentious public processes require that monitoring data and interpretive reports are easily available and arrive in a timely fashion. It is recommended that communication of progress needs to be presented in an annual report. The annual report will list all monitoring sites and data being collected as well as any updates or interesting news related to the ME&AMF. Staff will determine key messages with illustrative examples for each audience and make a report card, a brochure, and/or webpage(s) with relevant information. Some MPAs produce periodic synthetic reports that are continuously updated online or convene conferences that bring together scientists conducting monitoring and research activities, and these meetings can be used to serve a public reporting function. Other creative communication strategies using multimedia should be explored. Collaboration with departments of parks and recreation as well as local NGOs is encouraged to assist with outreach. Staff will create a dissemination strategy.

A more extensive annual report will be written year 3. This annual report will include a section on ME&AMF year 3 preliminary results. There will be a thorough review of the ME&AMF and evaluation of progress every 5 years. All of these reports require following the same communication strategy as described for the annual report.

3E. Intellectual and Physical Property Issues

There will be a need for clear guidelines governing ownership of data and associated intellectual property resulting from monitoring activities. These guidelines must address ownership of data collected by the people and organizations that will collect these data for the MPA array. This may include state agencies such as CDFG, as well as separate monitoring enterprises (PISCO, universities, other consortia, etc.) whose data are used in the monitoring and evaluation process.

Based upon discussions with SAT members, it is recommended that data collected for the MPA array should be owned by the State but made available for public access if requested by

the public, and data collected by separate monitoring enterprises should be jointly owned by the original collectors and the State. This arrangement should be spelled out in an MOU.

There should also be clear guidelines to govern shared physical property used in data collection. This may involve boats and other vehicles, monitoring instruments, laboratories, etc. It is recommended that these guidelines be accomplished through an MOU between the various public and private entities who will be sharing equipment.

4 Regional Implementation Plan

Assuming that the ME&AMF will coincide with the Nearshore Fisheries Management Plan regions, each of the four regions will make a Regional Monitoring and Evaluation and Adaptive Management Implementation Plan. Using the central coast as an example, we provide a framework and some guidance for developing these plans.

4A. Central Coast Regional Goals and Objectives

Appendix 3 summarizes the full suite of Central Coast CCRSG regional goals and corresponding objectives. The regional goals come directly from the CCRSG and are derived from the statewide goals in section 2853(b) of the initiative These goals are general, comprehensive statements meant to guide large-scale marine ecosystem conservation, protection, and management. However, they are not meant to serve directly as a basis for monitoring, evaluation, and adaptive management of individual MPAs or the network as a whole. Monitoring needs to address the full set of MPA objectives.

In order to design an effective and efficient monitoring and adaptive management plan, these MPA objectives must be further translated into questions for which data can be reasonably obtained. A first step in this process has already been accomplished by the CCRSG in developing for each regional goal a number of more specific regional objectives. These specific objectives provide operational definitions for each goal. These regional objectives, while more specific than the overarching goals, do not directly serve as the basis for monitoring. They, too, must be further translated into a series of corresponding focused questions that will be monitored over time to determine relative change.

4B. Questions, Indicators and Measurements of Progress

The topic of indicators and measuring performance is a big debate among scientists and managers. Currently, NOAA's MPA Center is hosting workshops with experts from around the United States to recommend a suite of indicators for the National MPA Network on Marine Natural Heritage. This project has proceeded for months, but NOAA's working group now has a comprehensive list of indicators for the natural sciences that it is still narrowing down to a suite of seven indicators. Syms and Carr (2001) propose a set of parameters for individual and networked conservation MPAs, with parameters at the species, community, and ecosystem level (see Appendix 7).

Translation of objectives into questions and indicators

The process for translating objectives into questions has not been done in many places. However, places like GBRMPA and the Florida Keys National Marine Sanctuary (FKNMS) have prioritized research agendas by following a scientific process.

The following case study offers an example of the process that provides valuable lessons. GBRMPA recently presented a detailed list of priority research questions for park management (GBRMPA 2005). They underwent a process to identify the most important research questions for park management. These research questions fall under a number of topic areas that are linked and cross-referenced with the Australian National Research Priorities, the GBRMPA's Key Performance Indicators, and key legislative or policy requirements (GBRMPA 2005). The full list of over 270 research needs was condensed to 21 priority questions. The final 21 were deemed to be critical in importance, with answers needed within one to three years for these questions. To determine this list, GBRMPA started in 2001 and went through extensive consultation with staff, the scientific community, and GBRMPA's Tourism and Recreation Reef Advisory Committee. The list was updated in 2002, based on informal review and discussion with the wider scientific and stakeholder communities, and on further consultation with the Critical Issues and other groups within GBRMPA. It was revised and reviewed again in 2004 (GBRMPA 2005). This process was long and incorporated intensive stakeholder feedback. This timeline will not work from the MLPA ME&AMF. What we can learn from this process, however, is that having input from various stakeholders and policymakers at this stage is important in creating support for and trust in management and policy decisions.

Indicators can be selected in a number of different ways. Florida Keys National Marine Sanctuary (FKNMS) designed a conceptual model to determine which parameters to monitor (FKNMS, 2003). They decided that a conceptual model would help determine the relative importance of known functions on the major biological components of the ecosystem and help identify critical parameters to monitor in order to detect changes in important attributes of the ecosystem. The FKNMS conceptual model "is meant to be a starting point in summarizing (the) knowledge of the Florida Keys marine ecosystem, and to help identify areas of required research and measures to monitor its 'pulse' (FKNMS, 2003). FKNMS recognized the importance of quantifiable measures through research and long-term monitoring, integrated across disciplines and at geographic and temporal scales of natural oceanic processes, upon which the human impacts they seek to manage are superimposed (FKMNS, 2003). Managers may assess what is already being monitored and propose the same monitoring agenda.

Applying lessons from the two examples above to the Central Coast and other regions in California, we realize that it will be necessary to have policymakers and stakeholders involved in the translation of goals and objectives into questions that may be answered through monitoring. We recommend that the indicators be simple and understood by all stakeholders; however, they need to be selected through a scientific process. While this step of translating the objectives into a set of questions is very difficult, it is crucial to successful adaptive management of the MPA array. It is critical to establish a clear and unambiguous statement of the desired outcome, while simultaneously considering variability and confounding factors in

ecosystem variables and understanding the long-time scale for ecosystem response (NFCC 2004, NOAA 2004). Policymakers and stakeholders must prioritize and determine what they value, for example biodiversity and/or high trophic species, and define a vision of success for the future. All of these challenges can, with effort, be overcome. Decision-makers, stakeholders, and scientists must systematically work together to arrive at questions derived from the more general goals and objectives. Ultimately, the questions must be able to stand on their own and require little or no further translation or explanation. A tool to assist in this process is the conceptual model. Conceptual models are now a widely used tool in ecosystem management projects nationwide to help formalize and articulate assumptions about ecosystem structure and function and the anticipated responses to management interventions.

Benchmarks or Relative Change

Creating benchmarks or determining progress towards an MPA objective is extremely challenging. The Channel Islands MPA monitoring plan does not use absolute benchmarks (e.g. x% kelp canopy cover or some specific value of a species diversity index). Rather, it defines performance relative to unprotected areas or other suitable reference locations. This decision resulted from the recognition of formidable uncertainty in processes, confounding variables, and a number of other factors (CDFG 2004). The Channel Islands MPA network will be considered as performing satisfactorily, for example, if the biological trends within MPAs approach given estimates of potential change more rapidly than areas outside of the MPA. This approach could be applied to the regions.

In measuring relative performance, there are a variety of options for selecting the performance metrics or benchmarks, and the appropriate option may depend on the indicator under consideration. Some possible ways to establish relative performance metrics entail asking:

- Is there a statistically significant difference in some quantity when measured in the MPA vs. a reference site (or a Year 0) in some specified time interval?
- Is there a statistically significant difference of some specified amount (e.g. 20% greater) in some quantity when measured in the MPA vs. a reference site (or a Year 0) in some specified time interval?

The National Fisheries Conservation Center (NFCC) report addressed the challenge of long-time horizons for detecting changes in marine MPAs. In such circumstances, the report suggests that monitoring “should focus on interim benchmarks of progress that reflect an underlying mechanistic understanding about how the MPA is expected to produce its desired effect(s)” (NFCC 2004). Syms and Carr propose determining targets, specified levels, or directions for each of these parameters or response variable, as well as assessing whether or not there are limits or acceptable deviations from specific targets.

Indicator Issues

The NOAA Working Group Natural Heritage identified several variables to consider when selecting indicators:

- Sensitivity (statistical power): ability of data to identify an effect or change
- Can a target be determined
- Can a threshold be determined
- Timeline: length of time for a metric to respond to a management action
- Ease of collecting data
- Cost to acquire data
- Response rate
- Variance: natural variability
- Translatable to the public

Other issues to consider include, for example, fisheries independent and fisheries dependent. There are a number of ways in which these data can be biased because the purpose of fishing is to catch fish rather than to measure objectively fish stocks (CDFG 2005). The scientists on the AMC will need address this issue when selecting indicators.

Fulton *et. al.* (2005) developed simulation models to test what ecological indicators can robustly detect effects of fishing. This study evaluated a suite of indicators covering species, assemblages, habitats, and ecosystems. The study found that indicators at the community level were the most reliable; however, it is necessary to use a variety of indicators simultaneously to detect the full range of impacts (Fulton, *et. al*, 2005).

Recommendations

For the development of the regional monitoring, evaluation, and adaptive management plans we recommend a process in which the AMC policymakers and staff translate the questions and these questions are, in turn, reviewed by all different groups. Another key point to keep in mind is that the public needs indicators they can understand. There should be collaboration with NOAA so as not to re-invent the wheel for development of indicators. In addition, for the indicators and determining progress towards an objective, a science-based process is necessary to design the most robust and strategic program. Some indicators and benchmarks may be stated, and some may not. This will be determined by the scientists on the AMC. Furthermore indicators and methods must be consistent across the state and it is critical for the *Monitoring and Evaluation Report* to be regularly reviewed and updated as more regions begin and add to this process. Below is an illustrative example to show what types of questions could be translated and developed from the central coast goals and objectives and what could be good indicators to monitor. This is a thorough list and by no means do all of these questions need to be answered and indicators monitored. Table 4 was reviewed by the SAT and MLPA staff. We recommend that each AMC for each region develops their own questions and indicators in the context of the goals and requirements of the Act.

Table 4: Illustrative Table of Objectives Translated into Questions for the Central Coast

Goal 1: To protect the natural diversity and abundance of marine life, and the structure, function, and integrity of marine ecosystems.

Objective	Translated into Measurable Questions	Indicator(s)	Baseline data[3]
1. Protect areas of high species diversity and maintain species diversity and abundance, consistent with natural fluctuations, of populations in representative habitats.	1. Do focal species inside MPAs increase in size, numbers, and biomass relative to areas of similar habitat adjacent to and distant from MPAs?	Differential change in focal species size structure, age structure, abundance, and/or biomass inside MPAs vs. outside	Size/age structure of focal species, abundance and biomass measures; species richness and diversity in all key habitats
	2. Do species richness and/or diversity increase in MPAs relative to areas of similar habitat adjacent to and distant from MPAs?	Differential change in species richness or diversity inside MPAs vs. outside	same as above
	3. Over what time period does the relative change take place for different species?	same as above	
2. Protect areas with diverse habitat types in close proximity to each other.	1. Has the selected alternative of MPAs protected areas with diverse habitat types in close proximity?	Baseline habitat mapping of all MPAs and adjacent sites; assessment of habitat diversity inside and outside MPAs	Baseline habitat mapping (all habitats, not just seafloor)

[3] Important to clarify that best readily available data that has been collected may not be the appropriate baseline data.

3. Protect natural size and age structure and genetic diversity of populations in representative habitats.	1. Do focal species inside marine reserves increase in size, numbers, and biomass relative to areas of similar habitat adjacent to and distant from MPAs?	Differential change in focal species size structure, age structure, abundance and/or biomass inside marine reserves vs. marine parks or marine conservation areas vs. outside	Size/age structure of focal species, abundance and biomass measures; species richness and diversity in al key habitats
4. Protect natural trophic structure and food webs in representative habitats.	1. Do the abundance and size/age structure of key predator and prey species differ inside marine reserves and marine parks, marine conservation areas, or outside areas of comparable habitat?	Differential change in abundance and size/age structure of key species at different trophic levels (note- not all species expected to increase)	Size/age structure of focal species, abundance and biomass measures; species richness and diversity in all key habitats
5. Protect ecosystem structure, function, integrity, and ecological processes to facilitate recovery of natural communities from disturbances both natural and human induced.	1. Do changes in fishing effort affect abundance, size/age structure of populations of selected species within and /or close reserves?	Differential change in focal species size structure, age structure, abundance and/or biomass inside marine reserves vs. marine parks or marine conservation areas vs. outside	Size/age structure of focal species, abundance and biomass measures; species richness and diversity in all key habitats
	2. Does impaired water quality or other outside factors inhibit populations within reserves?	Measurement of a variety of environmental parameters that may affect populations of monitored species	Broad suite of environmental parameters
	3. What is the level of adult spillover/movement?	Catch per unit effort, size, date, and location of tag and recapture	Fishing effort and catch data
	4. Does the nature or timing of recovery of natural communities from disturbance events differ in different types of MPAs relative to outside areas?	TBD: indicator depends on nature of disturbance	Recruitment of ecosystem engineers or keystone species

Goal 2. To help sustain, conserve, and protect marine life populations, including those of economic value, and rebuild those that are depleted.

Objective	Translated into Measurable Questions	Indicator(s)	Baseline data
1. Help protect or rebuild populations of rare, threatened, endangered, depleted, or overfished species, where identified, and the habitats and ecosystem functions upon which they rely.	1. Do focal species inside MPAs increase in size, numbers, and biomass relative to areas of similar habitat adjacent to and distant from MPAs?	Predicted differential change in rare/threatened/depleted species size structure, age structure, abundance and/or biomass inside MPAs vs. outside	Size/age structure of rare/threatened/depleted species, abundance and biomass measures; species richness and diversity in all key habitats
2. Protect larval sources and restore reproductive capacity of species most likely to benefit from MPAs through retention of large, mature individuals.	1.Do recruitment rates of selected species change over time inside marine reserves versus areas outside?	Differential recruitment[4] of selected species inside and outside MPAs	Baseline juvenile and adult population abundance; recruitment rates inside and outside marine reserves
	2. Does recruitment affect adult abundance inside and outside MPAs?	Correlation of recruitment rates with adult abundances inside and outside MPAs	same as above
	3. Do reserves retain large, mature, fecund individuals of selected species?	Differential changes in size, age, and expected fecundity over time for individuals inside marine reserves versus marine parks, marine conservation areas, or outside areas	Size, abundance, and fecundity of selected species inside and outside marine reserves

[4] **Recruitment**: The amount of fish added to the exploitable stock each year due to growth and/or migration into the fishing area. For example, the number of fish that grow to become vulnerable to the fishing gear in one year would be the recruitment to the fishable population that year. This term is also used in referring to the number of fish from a year class reaching a certain age. For example, all fish reaching their second year would be age 2 recruits. (Source: "Technical Terms" **NOAA's National Marine Fisheries Service Northeast Fisheries Science Center** http://www.nefsc.noaa.gov/techniques/tech_terms.html)

	4. What is the relative effectiveness for the designated levels of protection? This will be answered by answering the question how does the marine system respond to different levels of protection (SMCA, SMPA, SMR) for a variety of species?	Differential changes in size, age, and expected fecundity over time for a variety of species inside marine reserves versus marine parks, marine conservation areas, or outside areas	Size, abundance, and fecundity of selected species inside and outside marine reserves
3. Protect selected species and the habitats on which they depend while allowing the harvest of migratory, highly mobile, or other species where appropriate through the use of state marine conservation areas and state marine parks.	1. Do the presence of marine parks and marine conservation areas affect fishing patterns for migratory and highly mobile species?	Distribution of catch by block and species group where caught and port where landed	Logbook, CPFV, CRFS data
	2. Are people fishing the boundary or "edge" of a reserve and what are they fishing for? Is there crowding on the edge of the reserve?	Distribution of catch by block and species group where caught and port where landed	Logbook, CPFV, CRFS data

Goal 3. To improve recreational, educational, and study opportunities provided by marine ecosystems that are subject to minimal human disturbances, and to manage these uses in a manner consistent with protecting biodiversity.

Objective	Translated into Measurable Questions	Indicator(s)	Baseline data
1. Ensure some MPAs are close to population centers and research and education institutions and include areas of traditional non-consumptive recreational use and are accessible for recreational, educational, and study opportunities.	1. How do population concentrations change along the coast? How does attendance/visitation change over time?	Measure distance to major population centers, census data. Measure ease of access, distance from major highways, parking availability, public transit. Attendance and visitation data should be stratified by uses and demographics over time.	Year 1 visitor use surveys
	2. Has research increased over time in MPAs and are results disseminated?	Trends in # of research studies conducted in MPAs over time; dissemination of results of research studies within CA MPAs (science citation search or similar).	Year 1 survey of research publications

	3. Are recreational consumptive users able to mitigate short-term costs of displacement from MPAs by conducting activities along the edge of MPAs? Will there be long-term benefits from the edge effect?	Changes in use patterns and catch of targeted species by consumptive users over time.	Year 1 consumptive use survey
	3. How are knowledge, attitudes, and perceptions regarding the MPAs changing over time?	Public and user group knowledge, attitudes, and perceptions of MPAs	Year 1 public/user knowledge survey
2. To enhance the likelihood of scientifically valid studies, replicate appropriate MPA designations, habitats, or control areas (including areas open to fishing) to the extent possible.	1. Has selected alternative provided a full range of replicate habitats and MPA designations?	Number of each type of MPA and indication of habitat replication inside and outside	Baseline habitat mapping (all habitats) and identification of comparable "impact" sites
3. Develop collaborative scientific monitoring and research projects evaluating MPAs that link with fisheries management information needs, classroom science curricula, volunteer dive programs, and fishermen of all ages, and identify participants.	1. Does access to central coast MPAs by educators/students increase through time?	Number and type of user of all MPAs	Baseline assessment of educational programs and use of MPAs
	2. Are researchers accessing the MPAs?	Number and type of research projects or programs carried out in MPAs	Any existing research programs present (PISCO, CRANE, etc.)?
4. Protect or enhance recreational experience by ensuring natural size and age structure of marine populations.	1. Are non-consumptive recreational experiences in areas subject to minimal disturbance improving? What are the attitudes and perceptions of users and their recreational experience and how has that changed over time?	Predicted increase in user group satisfaction based on user group surveys	Baseline assessment of knowledge, attitudes and perceptions. Year 1 user survey related to experience w/ marine populations. Thereafter survey annually.
	2. Are size and age structure of recreationally valued species increasing in SMRs over time?	Differential size/age structure of selected species inside and outside MPAs over time; onboard and dockside sampling of recreational catch, location, and effort.	Size/age structure of selected species; CA Recreational Fishery Survey data

Goal 4. To protect marine natural heritage, including protection of representative and unique marine life habitats in central California waters, for their intrinsic value.

Objective	Translated into Measurable Questions	Indicator(s)	Baseline data
1. Include within MPAs the following habitat types: estuaries, heads of submarine canyons, and pinnacles.	1. Did the selected alternative set of MPAs capture sufficient representation of estuaries, canyon heads, and pinnacles?	Habitat mapping within MPAs to groundtruth what is captured in MPAs. Gap analysis for unique habitats.	Baseline habitat mapping
2. Protect, and replicate to the extent possible, representatives of all marine habitats identified in the MLPA or the MPF across a range of depths.	1. Did the selected alternative set of MPAs capture sufficient representation of all central coast habitats?	Habitat mapping within MPAs to groundtruth what is captured in MPAs. Gap analysis for all habitats.	Baseline habitat mapping

Goal 5. To ensure that central California's MPAs have clearly defined objectives, effective management measures, and adequate enforcement, and are based on sound scientific guidelines.

Objective	Translated into Measurable Questions	Indicator(s)	Baseline data
1. Minimize negative socioeconomic impacts and optimize positive socioeconomic impacts for all users, to the extent possible and if consistent with the Marine Life Protection Act and its goals and guidelines.	1. Is the commercial catch or income changing along the central coast?	Quantity and value of catch and relative changes in fisheries	Commercial Fish Landing Receipts
	2. Are commercial catch per unit effort (CPUE), or fishing locations changing along the central coast?	Location, catch per unit effort, and presence and/or amount of displaced effort	Commercial Fish Log Books
	3. Are recreational catch per unit effort (CPUE) or fishing locations changing along the central coast?	Location, level of effort, species, size and amount of catch from recreational fisheries	California Recreational Fishery Survey
	4. Are locations of fishing and boating activities changing?	Level and location of fishing and boating, presence and/or amount of displace effort	

	5. Do impacts financially harm individual businesses? Do impacts harm local and or regional economies?	Monitor use, catch, and value	
	6. Are use, attendance, and visitation changing over time along the Central Coast?	Identify users and attendance and visitation	Baseline and recurring surveys and determine decline, maintenance, or an increase
	7. What is the real value of expenditures associated with identified users?	Surveys to estimate expenditures associated with activities above	Baseline and recurring surveys and determine decline, maintenance, or an increase
	8. How many companies and jobs are associated with identified uses and how has this changed over time?	Surveys to estimate number of companies and jobs that rely on user groups/activities	Baseline and recurring surveys and determine decline, maintenance, or an increase
	9. What is the non-market value per visit and total non-market values and how has that changed over time?	Surveys to estimate non-market value of these activities	Baseline and recurring surveys and determine decline, maintenance, or an increase
2. For all MPAs in the region, develop objectives, a long-term monitoring plan that includes standardized biological and socioeconomic monitoring protocols, and a strategy for MPA evaluation, and ensure that each MPA objective is linked to one or more regional objectives.	1. Are all MPAs in the region developing objectives and do they have a monitoring and evaluation program linked to one or more regional objective?	Number of MPAs with objectives linked to regional objectives, with long-term M & E plans linked to objectives	
	2. Are all MPAs using standardized biological and socioeconomic monitoring protocols?	Number of MPAs using standardized monitoring protocol	
	3. Is each MPA effective in meeting its stated objectives?	Measure indicators linked to objectives, changes in use patterns over time, changes in biological resources over time	
3. To the extent possible, effectively use scientific guidelines in the Master Plan Framework.	NA - will be part of evaluation		

Goal 6. To ensure that the Central Coast's MPAs are designed and managed, to the extent possible, as a component of a statewide network.

Objective	Translated into Measurable Questions	Indicator(s)	Baseline data
1. Develop a process for regional review and evaluation of implementation effectiveness that includes stakeholder involvement to determine if regional MPAs are an effective component of a statewide network.	1. Is there a process for regional review and evaluation of MPA effectiveness that includes stakeholders?	Stakeholder knowledge of process, number of opportunities for stakeholder comment, number of reports and data sets available to the stakeholders	NA
	2. Are individual and regional MPA arrays effective in building a statewide "network"?	Changes in biological resources over time; changes in use patterns over time; improvement in monitoring and management over time	NA
2. Develop a mechanism to coordinate with future MLPA regional stakeholder groups in other regions to ensure that the statewide MPA network meets the goals of the MLPA.	1. Is there a process for central coast stakeholders to engage with neighboring regions to ensure meeting statewide goals of MLPA?	Mechanism for statewide coordination	NA
	2. Is there coordination of MPA planning at the boundaries of study regions to ensure network connectivity and address any potential conflicts?	Mechanism for statewide coordination	NA

4C. Regional Monitoring Programs and Partnership

Regional Monitoring Programs

The scientific research within the central coast study region is diverse, ranging from water quality and fisheries management to deep sea biology, kelp forest ecology, and ocean conservation. Major marine monitoring programs in the region include Cooperative Research and Assessment of Nearshore Ecosystems (CRANE), Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO), Central California Ocean Observing System (CEENOS), Monterey Bay National Marine Sanctuary Integrated Monitoring Network (SIMoN), and Center for Integrative Coastal Observation, Research and Education (CI-CORE), to name a few (see table 5). These organizations implement diverse marine research programs.

Data from major marine monitoring programs, small scientific studies, or even volunteer monitoring such as Citizen Watershed Monitoring Network in the Monterey Bay National Marine Sanctuary developed by U.S. Environmental Protection Agency may be used for the monitoring and evaluation if the indicators decided upon by the adaptive management council are parameters being collected by one of these entities.

Monitoring programs could be assessed to see if they are collecting the right type of data for the MLPA program. Often times the parameters being collected for a long-term monitoring program focus on different questions and may have different goals and objectives not in line with the purpose of monitoring, evaluation, and adaptive management. If the entity(ies) are collecting a desired parameter (s), the ME&AMF implementation staff would ask to for these data to be peer reviewed and assessed for quality control. ME&AMF would then establish an MOU between the monitoring program and California Resources Agency to make the data available for this process as well as available to the public. Volunteer and community monitoring programs have benefits that are not just solely for scientific purposes. By engaging in monitoring, a community group can play an active role in management. Active involvement and participation by a community group will enable the group to increase their local knowledge and awareness of MPAs, connect further with the marine environment, and enjoy the wonders of California's unique marine plants and animals.

Many concentrated studies take place near marine research stations. Examples include the marine mammal studies at Terrace Point by Long Marine Lab, evolutionary physiology, biomechnanics, and ecology studies at Point Cabrillo by Hopkins Marine Station, and fishery and fish population studies at Big Creek State Marine Reserve. PISCO focuses on long-term ecological and oceanographic monitoring to inform ocean conservation and management. Long-term Monitoring Program & Experiential Training for Students (LIMPETS) trains middle- and high-school students and volunteer groups to monitor the rocky intertidal, sandy shore and offshore areas of Monterey Bay and Channel Islands to increase public awareness and influence policy makers. Elkhorn Slough National Estuarine Research Reserve's (ESNERR) monitoring programs target water quality and weather. The Santa Cruz Laboratory, part of the Southwest Fisheries Science Center of the National Marine Fisheries Service (NMFS), focuses on the Pacific Coast Groundfish and Pacific Salmon. NOAA has the National MPA Center and

the Fisheries Lab. These examples illustrate the importance and diversity of marine research along the central coast. Map 1 shows provides location information for marine monitoring sites in and around the MLPA study region from the CeNCOOs, PISCO, LIMPET, and Multi-Agency Rocky Intertidal Network (MARINe) programs (see Table 5).

Table 5: Research and Monitoring Programs in the Study Region

CALCOFI Since 1949 California Cooperative Oceanic Fisheries Investigations (CalCOFI) has organized cruises to measure the physical and chemical properties of the California Current System and census populations of organisms from phytoplankton to avifauna. On each cruise a grid of 66 stations off Southern California is occupied. At each station a whole suite of physical and chemical measurements characterize the environment and map the distribution and abundance of phytoplankton, zooplankton, and fish eggs and larvae. http://www.calcofi.org/
CeNCOOS The Central California Ocean Observing System is a new initiative and part of the national ocean observing system, the Integrated Ocean Observing System (IOOS). http://www.cencoos.org/
CRANE Cooperative Research and Assessment of Nearshore Ecosystems (CRANE) was established in spring 2003. CRANE uses quantitative diver visual surveys to sample kelp forests for fishes, invertebrates, and algae.
LiMPETS LiMPETS is for middle school, high school, and other volunteer groups to monitor the rocky intertidal, sandy shore and offshore areas of the five west coast National Marine Sanctuaries. http://limpets.noaa.gov/
MARINe Scientists from Federal, State, and local government agencies, universities, and private and volunteer organizations have formed MARINe to monitor important shoreline resources. The network is currently being supported by 23 organizations. Sites are monitored from San Luis Obispo County to San Diego County on the mainland and offshore Channel Islands. http://www.marine.gov/
PISCO PISCO is a large-scale marine research program that focuses on understanding the nearshore ecosystems of the U.S. West Coast. PISCO integrates long-term monitoring of ecological and oceanographic processes at dozens of coastal sites with experimental work in the lab and field. http://www.piscoweb.org/research/community/subtidal/index.html
SIMoN The SIMoN network is composed of many institutions and agencies that perform monitoring activities in the Monterey Bay National Marine Sanctuary and share their summary information with SIMoN. http://www.mbnms-simon.org/

As the statewide MPA array continues to develop, we encourage the use of "universal methods" drawn from the Channel Islands and this plan.

Map 1: Research, Educational Institutions, and Monitoring Sites in the Central Coast Study Region [Placeholder: XX is revising this map]

Partnerships

Organizing multiple partnerships can be challenging. Often times funding and priorities of participating organizations change and can compete for staff time and energy (Chornesky, 2005). One way to avoid this issue is to create a new organization and identity that can push the partnership(s) forward. The new organization with a new identity and a singular purpose and dedicated capacity allowed the partnership to move forward successfully (Chornesky, 2005). South Bay Salt Ponds Restoration and Southern California Coastal Water Research Project Authority are just two examples of organizations that were created with a partnership mandate that created accountability and developed long-term funding streams.

4D. Sample Table of Contents for a Regional Implementation Plan

A regional monitoring, evaluation and adaptive management implementation plan will be developed for each region. This document will lay out in Section 2 the regional goals and objectives and translate them into measurable questions and indicators to then be monitored and eventually evaluated over time. Section 3 will briefly outline methods. However, the *Monitoring and Evaluation Report* will be at the statewide level and will provide detailed information on universal methods, monitoring, and data management. Section 3 will also briefly present the regional research design, monitoring schedule, as well as data quality control and assurance and the data management. The final section will present an implementation plan that explains staffing, resource needs, and a workplan for the next three to five years. Section 4 will also discuss how adaptive management will be implemented in the plan. As with all of these documents, this regional plan will be modified over time as more knowledge is gained and as more regions make plans. Below is a sample table of contents for a regional monitoring, evaluation and adaptive management implementation plan.

Table 6: Sample Table of Contents for a Regional Monitoring, Evaluation, and Adaptive Management Implementation Plan

1. Overview

1A. MLPA requirements for M&E [will discuss M&E in context of MLPA and MPF]
1B. Purpose of this plan [will discuss link to other MLPA documents, M&E report, etc.]
1C. Linkage among statewide, regional, and site-specific goals and objectives and statewide adaptive management questions [will provide graphic that shows the relationship between multi-scale goals and objectives]
1D. Adaptive management [will briefly discuss the principle of adaptive management and how it will be incorporated into the regional plan]

2. Regional Goals and Objectives and Translation into Measurable Questions with Indicators

2A. List of goals and objectives [will provide table of regional goals and objectives]
2B. Questions derived from regional goals and objectives [will discuss indicators and the links and relevance to measuring success of the regional goals and objectives]
2C. Identification of indicators for each question [will describe each indicator for each question and goal/objective]
2D. Prioritization and review among indicators for each site [will review and prioritize indicators]
2E. Discuss selected benchmarks (if appropriate) [will briefly review indicators and quantifiable benchmarks (of progress on indicators) that will measure progress toward goals and objectives]

3. Methods and Research Design

3A. Indicators and methods [outline methods for data collection of each indicator]
3B. Research design [describe research design for all indicators]
3C. Indicators and monitoring schedule [present a monitoring schedule with locations and times for data collection for each indicator]
3D. Data quality control and assurance and management [outline process for data quality control and assurance and data management system]

4. Implementation Plan

4A. Partners [will discuss partnerships with other organizations and their existing monitoring programs and relevance to measuring indicators, with a map showing locations of monitoring sites relevant to MLPA indicators]
4B. Resource needs and staffing [will assess resource needs for measuring selected indicators]
4C. Communication of results [will present communications plan - discuss audiences targeted to receive results and dissemination, timing, medium etc.]
4D. Existing MPA M & E plans [will briefly review relevant monitoring and evaluation programs at existing MPAs and how these will be used for the region]
4E. M&E project phasing and workplan [will describe detail of implementation]
4F. Integration of adaptive management into the plan [will explain process and how adaptive management will work in the region]

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